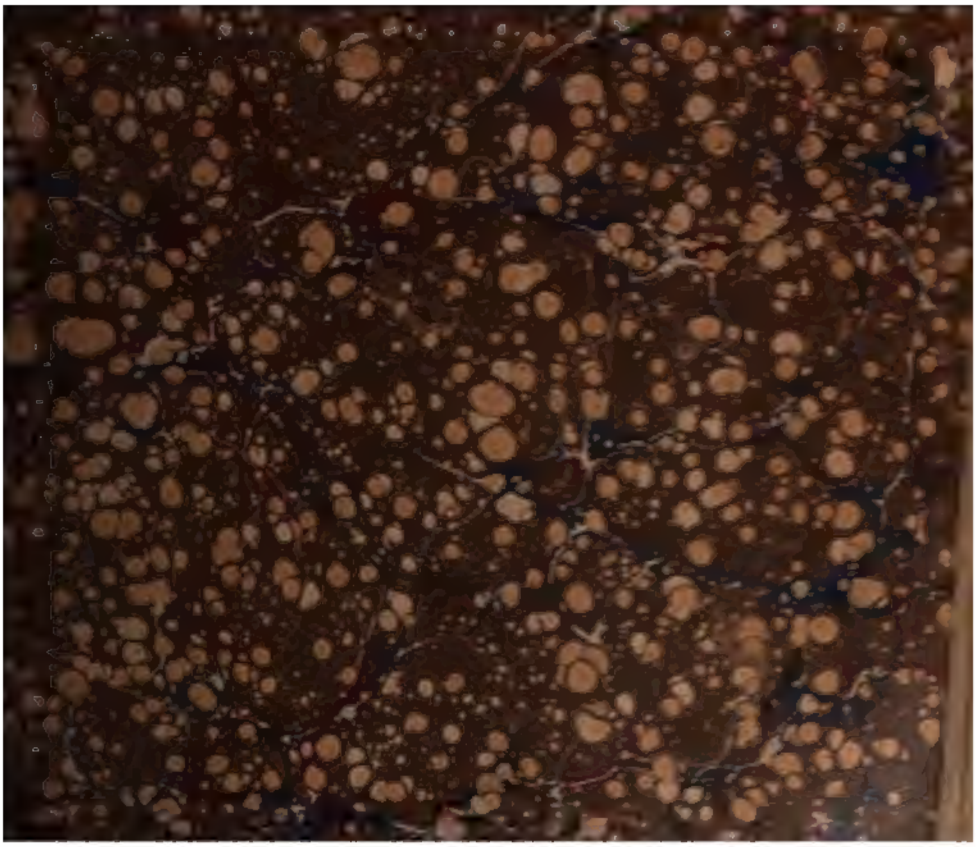

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PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXI. APRIL, 1883, TO JANUARY 4, 1884. No. 114.

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PROCEEDINGS

J C Branner

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THE TUTELO TRIBE AND LANGUAGE.

BY HORATIO HALE.

(Read before the American Philosophical Society, March 2, 1883.)

The tribes of the Dakota stock, under various designations—Osages, Quappas, Kansas, Otoes, Omahas, Minitarees (or Hidatsas), Iowas, Mandans, Sioux (or Dakotas proper) and Assiniboins, have always been regarded as a people of the western prairies, whose proper home was the vast region lying west of the Mississippi, and stretching from the Arkansas River on the south to the Saskatchawan on the north. A single tribe, the Winnebagoes, who dwelt east of the Mississippi, near the western shore of Lake Michigan, were deemed to be intruders into the territory of the Algonkin nations. The fact, which has been recently ascertained, that several tribes speaking languages of the Dakota stock were found by the earliest explorers occupying the country east of the Alleghenies, along a line extending through the southern part of Virginia and the northern portion of North Carolina, nearly to the Atlantic ocean, has naturally awakened much interest. This interest will be heightened if it shall appear that not only must our ethnographical maps of North America be modified, but that a new element has been introduced into the theory of Indian migrations. Careful researches seem to show that while the language of these eastern tribes is closely allied to that of the western Dakotas, it bears evidence of being older in form. If this conclusion shall be verified, the supposition, which at first was natural, that these eastern tribes were merely offshoots of the Dakota stock, must be deemed at least improbable. The course of migration may be found to have followed the contrary direction, and the western Dakotas, like the western Algonkins, may find their parent stock in the east. As a means of solving this interesting problem, the study of the history and language of a tribe now virtually extinct assumes a peculiar scientific value. Philologists will notice, also, that in this study there is presented to them a remarkable instance of an inflected language closely allied in its vocabu-

lary and in many of its forms to dialects which are mainly agglutinative in their structure, and bear but slight traces of inflection.

In the year 1671 an exploring party under Captain Batt, leaving "the Apomatock Town," on the James River, penetrated into the mountains of Western Virginia, at a distance, by the route they traveled, of two hundred and fifty miles from their starting point. At this point they found "the Tolera Town in a very rich swamp between a breach [branch] and the main river of the Roanoke, circled about by mountains."* There are many errata in the printed narrative, and the circumstances leave no doubt that "Tolera" should be "Totera." On their way to this town the party had passed the Sapong [Sapony] town, which, according to the journal, was about one hundred and fifty miles west of the Apomatock Town, and about a hundred miles east of the "Toleras." A few years later we shall find these tribes in closer vicinity and connection.

At this period the Five Nations were at the height of their power, and in the full flush of that career of conquest which extended their empire from the Georgian Bay on the north to the Roanoke River on the south. They had destroyed the Hurons and the Eries, had crushed the Andastes (or Conestoga Indians), had reduced the Delawares to subjection, and were now brought into direct collision with the tribes of Virginia and the Carolinas. The Toteras (whom we shall henceforth know as the Tuteloes) began to feel their power. In 1686 the French missionaries had occasion to record a projected expedition of the Senecas against a people designated in the printed letter the "Tolere,"—the same misprint occurring once more in the same publication.† The traditions of the Tuteloes record long continued and destructive wars waged against them and their allies by the Iroquois, and more especially by the two western nations, the Cayugas and Senecas. To escape the incursions of their numerous and relentless enemies, they retreated further to the south and east. Here they came under the observation of a skilled explorer, John Lawson, the Surveyor-General of South Carolina. In 1701, Lawson traveled from Charleston, S. C., to Pamlico sound. In this journey he left the sea-coast at the mouth of the Santee river, and pursued a northward course into the hilly country, whence he turned eastward to Pamlico. At the Sapona river, which was the west branch of the Cape Fear or Clarendon river, he came to the Sapona town, where he was well received.‡ He there heard of the Toteros as "a neighboring nation " in the "western mountains." "At that time," he adds, "these Toteros, Saponas, and the Keyawees, three small nations, were going to live together, by which they thought they should strengthen themselves and become formidable to their enemies."

*Batt's *Journal and Relation of a New Discovery*, in N. Y. Hist. Col. Vol. iii, p. 191.

†Lambreville to Bruyas, Nov. 4, 1686, in N. Y. Hist. Col., Vol. iii, p. 484.

‡Gallatin suggests that Lawson was here in error, and that the Sapona river was a branch of the Great Pedee, which he does not mention, and some branches which he evidently mistook for tributaries of the Cape Fear river.—*Synopsis of the Indian Tribes*, p. 85.

They were then at war with the powerful and dreaded Senecas—whom Lawson styles Sinnagers. While he was at the Sapona town, some of the Toteras warriors came to visit their allies. Lawson was struck with their appearance. He describes them, in his quaint idiom, as "tall, likely men, having great plenty of buffaloes, elks and bears, with every sort of deer, amongst them, which strong food makes large, robust bodies." In another place he adds: "These five nations of the Toteros, Saponas, Keiauwees, Aconechos and Schoicories are lately come amongst us, and may contain in all about 750 men, women and children."* It is known that the Toteroes (or Tuteloes) and Saponas understood each other's speech, and it is highly probable that all the five tribes belonged to the same stock. They had doubtless fled together from southwestern Virginia before their Iroquois invaders. The position in which they had taken refuge might well have seemed to them safe, as it placed between them and their enemies the strong and warlike Tuscarora nation, which numbered then, according to Lawson's estimate, twelve hundred warriors, clustered in fifteen towns, stretching along the Neuse and Tar rivers. Yet, even behind this living rampart, the feeble confederates were not secure. Lawson was shown, near the Sapona town, the graves of seven Indians who had been lately killed by the "Sinnegars or Jennitos"—names by which Gallatin understands the Senecas and Oneidas, though as regards the latter identification there may be some question.

The noteworthy fact mentioned by Lawson, that buffaloes were found in "great plenty" in the hilly country on the head waters of the Cape Fear river, may be thought to afford a clue to the causes which account for the appearance of tribes of Dakota lineage east of the Alleghenies. The Dakotas are peculiarly a hunting race, and the buffalo is their favorite game. The fact that the Big Sandy river, which flows westward from the Alleghenies to the Ohio, and whose head waters approach those of the Cape Fear river, was anciently known as the Totteroy river, has been supposed to afford an indication that the progress of the Toteros or Tutelos, and perhaps of the buffaloes which they hunted, may be traced along its course from the Ohio valley eastward. There are evidences which seem to show that this valley was at one time the residence, or at least the hunting-ground, of tribes of the Dakota stock. Gravier (in 1700) affirms that the Ohio river was called by the Illinois and the Miamis the Akansea river, because the Akanseas formerly dwelt along it.† The Akanseas were identical with the Quappas, and have at a later day given their name to the river and State of Arkansas. Catlin found reason for believing

* Lawson's "History of Carolina;" reprinted by Strother & Marcom. Raleigh, 1860; p. 384.

† "Elle" (the Ohio) "s'appelle par les Illinois et par les Oumiamis la rivière des Akanseas, parceque les Akanseas l'habitoient autrefois."—Gravier, Relation du Voyage, p. 10. I am indebted for this and other references to my esteemed friend, Dr. J. G. Shea, whose unsurpassed knowledge of Indian history is not more admirable than the liberality with which its stores are placed at the command of his friends.

that the Mandans, another tribe of the Southern Dakota stock, formerly —and at no very distant period—resided in the valley of the Ohio. The peculiar traces in the soil which marked the foundations of their dwellings and the position of their villages were evident, he affirms, at various points along that river. It is by no means improbable that when the buffalo abounded on the Ohio, the Dakota tribes found its valley their natural home, and that they receded with it to the westward of the Mississippi. But the inference that the region west of the Mississippi was the original home of the Dakotas, and that those of that stock who dwelt on the Ohio or east of the Alleghenies were emigrants from the Western prairies, does not, by any means, follow. By the same course of reasoning we might conclude that the Aryans had their original seat in Western Europe, that the Portuguese were emigrants from Brazil, and that the English derived their origin from America. The migrations of races are not to be traced by such recent and casual vestiges. The only evidence which has real weight in any inquiry respecting migrations in prehistoric times is that of language ; and where this fails, as it sometimes does, the question must be pronounced unsoluble.

The protection which the Tuteloes had received from the Tuscaroras and their allies soon failed them. In the year 1711 a war broke out between the Tuscaroras and the Carolina settlers, which ended during the following year in the complete defeat of the Indians. After their overthrow the great body of the Tuscaroras retreated northward and joined the Iroquois, who received them into their league as the sixth nation of the confederacy. A portion, however, remained near their original home. They merely retired a short distance northward into the Virginian territory, and took up their abode in the tract which lies between the Roanoke and the Potomac rivers. Here they were allowed to remain at peace, under the protection of the Virginian government. And here they were presently joined by the Tuteloes and Saponas, with their confederates. In September, 1722, the governors of New York, Pennsylvania, and Virginia, held a conference at Albany with the chiefs of the Iroquois, to endeavor to bring about a peace between them and the southern tribes. On this occasion Governor Spotteswood, of Virginia, enumerated the tribes for which the government of his Province would undertake to engage. Among them were certain tribes which were commonly known under the name of the "Christanna Indians," a name derived from that of a fort which had been established in their neighborhood. These were "the Saponies, Ochineeches, Stenkenoaks, Meipontskys, and Toteroes," all of whom, it appears, the Iroquois were accustomed to comprehend under the name of Todirichrones.*

Some confusion and uncertainty, however, arise in consulting the colonial records of this time, from the fact that this name of Todirichrones was applied by the Iroquois to two distinct tribes, or rather confederacies, of Southern Indians, belonging to different stocks, and speaking languages

* N. Y. Hist. Col., Vol. v, p. 655 et seq.

totally dissimilar. These were, on the one hand, the Tuteloes (or Toteroes) and their allies, and, on the other, the powerful Catawba nation. The Catawbas occupied the eastern portion of the Carolinas, south of the Tuscarora nation. At the beginning of the last century they numbered several thousand souls. As late as 1743, according to Adair, they could still muster four hundred warriors. A bitter animosity existed between them and the Iroquois, leading to frequent hostilities, which the English authorities at this conference sought to repress. It was the policy of the Iroquois, from ancient times, always to yield to overtures of peace from any Indian nation. On this occasion they responded in their usual spirit. "Though there is among you," they replied to the Virginians, "a nation, the Todirichrones, against whom we have had so inveterate an enmity that we thought it could only be extinguished by their total extirpation, yet, since you desire it, we are willing to receive them into this peace, and to forget all the past."*

The Catawba language is a peculiar speech, differing widely, if not radically, both from the Dakota and from the Iroquois languages.† The only connection between the Catawbas and the Tuteloes appears to have arisen from the fact that they were neighboring, and perhaps politically allied tribes, and were alike engaged in hostilities with the Iroquois. The latter, however, seem to have confounded them all together, under the name of the tribe which lay nearest to the confederacy and was the best known to them.

One result of the peace thus established was that the Tuteloes and Saponas, after a time, determined to follow the course which had been taken by the major portion of their Tuscarora friends, and place themselves directly under the protection of the Six Nations. Moving northward across Virginia, they established themselves at Shamokin (since named Sunbury) in what is now the centre of Pennsylvania. It was a region which the Iroquois held by right of conquest, its former occupants, the Delawares and Shawanese, having been either expelled or reduced to subjection. Here, under the shadow of the great confederacy, many frag-

* N. Y. Hist. Col., Vol. v, p. 660.

† Gallatin, in his Synopsis classes the Catawba as a separate stock, distinct from the Dakota. The vocabulary which he gives seems to warrant this separation, the resemblances of words being few and of a doubtful character. On the other hand, in the first annual report of the Bureau of Ethnology connected with the Smithsonian Institution (Introduction, p. xix) the Katâba (or Catawba) is ranked among the languages of the Dakotan family. My esteemed correspondent, Mr. A. S. Gatschet, whose extensive acquaintance with Indian linguistics gives great weight to his opinion on any subject connected with this study, informs me (March 31, 1882) that this classification was conjectural and provisional, and that his subsequent researches among the few survivors of the tribe have not yet resulted in confirming it. They show certain traces of resemblance, both in the vocabulary and the syntax, but too slight and distant to make the affiliation certain. We shall have, as he remarks, "to compare more material, or more attentively that which we have, to arrive at a final result."

ments of broken tribes were now congregated—Conoys, Nanticokes, Delawares, Tuteloes, and others.

In September, 1745, the missionary, David Brainerd, visited Shamokin. He describes it in his diary as containing upwards of fifty houses and nearly three hundred persons. "They are," he says, "of three different tribes of Indians, speaking three languages wholly unintelligible to each other. About one half of its inhabitants are Delawares, the others Senekas and Tutelas."* Three years later, in the summer of 1748, an exploring party of Moravian missionaries passed through the same region. The celebrated Zeisberger, who was one of them, has left a record of their travels. From this we gather that the whole of the Tuteloes were not congregated in Shamokin. Before reaching that town, they passed through Skogari, in what is now Columbia county. In Zeisberger's biography the impression formed of this town by the travelers is expressed in brief but emphatic terms. It was "the only town on the continent inhabited by Tuteloes, a degenerate remnant of thieves and drunkards."† This disparaging description was perhaps not unmerited. Yet some regard must be paid to a fact of which the good missionary could not be aware, namely, that the Indians who are characterized in these unsavory terms belonged to a stock distinguished from the other Indians whom he knew by certain marked traits of character. Those who are familiar with the various branches of the Indian race are aware that every tribe, and still more every main stock, or ethnic family, has certain special characteristics, both physical and mental. The Mohawk differs in look and character decidedly from the Onondaga, the Delaware from the Shawanese, the Sioux from the Mandan ; and between the great divisions to which these tribes belong, the differences are much more strongly marked. The Iroquois have been styled "the Romans of the West." The designation is more just than is usual in such comparisons. Indeed, the resemblance between these great conquering communities is strikingly marked. The same politic forethought in council, the same respect for laws and treaties, the same love of conquest, the same relentless determination in war, the same clemency to the utterly vanquished, a like readiness to strengthen their power by the admission of strangers to the citizenship, an equal reliance on strong fortifications, similar customs of forming outlying colonies, and of ruling subject nations by proconsular deputies, a similar admixture of aristocracy and democracy in their constitution, a like taste for agriculture, even a notable similarity in the strong and heavy mould of figure and the bold and massive features, marked the two peoples who, on widely distant theatres of action, achieved not dissimilar destinies.

Pursuing the same classical comparison, we might liken the nearest neighbors of the Iroquois, the tribes of the Algonkin stock, whose natural traits are exemplified in their renowned sachems, Powhatan, Philip of Pokano-

* Life of Brainerd, p. 167, Am. Tract Soc. edition. Quoted in the "Life of Zeisberger," by De Schweinitz, p. 71.

† Life of Zeisberger, by De Schweinitz, p. 149.

ket, Miantanomah, Pontiac, and Tecumseh, to the ingenious and versatile Greeks, capable of heroism, but incapable of political union, or of long-sustained effort. A not less notable resemblance might be found between the wild and wandering Scythians of old, and the wild and wandering tribes of the great Dakotan stock. Reckless and rapacious, untamable and fickle, fond of the chase and the fight, and no less eager for the dance and the feast, the modern Dakotas present all the traits which the Greek historians and travelers remarked in the barbarous nomads who roamed along their northern and eastern frontiers.

The Tuteloes, far from the main body of their race, and encircled by tribes of Algonkin and Iroquois lineage, showed all the distinctive characteristics of the stock to which they belonged. The tall, robust huntsmen of Lawson, chasers of the elk and the deer, had apparently degenerated, half a century later, into a "remnant of thieves and drunkards," at least as seen in the hurried view of a passing missionary. But it would seem that their red-skinned neighbors saw in them some qualities which gained their respect and liking. Five years after Zeisberger's visit, the Iroquois, who had held them hitherto under a species of tutelage, decided to admit them, together with their fellow-refugees, the Algonkin Nanticokes from the Eastern Shore of Maryland, to the full honors of the confederacy. The step received the commendation of so shrewd a judge as Colonel (afterwards Sir William) Johnson. At a great council of the Six Nations, held at Onondaga in September, 1753, Colonel Johnson congratulated the Cayugas on the resolution they had formed of "strengthening their castle" by taking in the Tedarighroones.* At about the same time a band of Delawares was received into the League. When a great council was to be convened in 1756, to confer with Colonel Johnson on the subject of the French war, wampum belts were sent to nine "nations" of the confederacy.† From this time the chiefs of the Tuteloes, as well as o the Nanticokes and the Delawares, took their seats in the Council of the League, a position which they still hold in the Canadian branch of the confederacy, though the tribes whom they represent have ceased to exist as such, and have become absorbed in the larger nations.

It would seem, however, that their removal from their lands on the Susquehanna to the proper territory of the Six Nations did not take place immediately after their reception into the League, and perhaps was never wholly completed. In an "account of the location of the Indian tribes," prepared by Sir William Johnson in November, 1763, the four small tribes of "Nanticokes, Conoys, Tutecoes [an evident misprint] and Saponeys," are bracketed together in the list as mustering in all two hundred men, and are described as "a people removed from the southward, and settled on or about the Susquehanna, on lands allotted by the Six Nations."‡

Though the Tuteloes were thus recognized as one of the nations of the

* N. Y. Hist. Col. Vol. vi, p. 811.
† Stone's Life of Sir William Johnson, Vol. i, p. 484.
‡ *Ibid.*, Vol. ii, p. 487.

confederacy, and as such kept up their distinct tribal organization, they were regarded as being in a special manner the friends and allies of the Cayugas. The latter, a tribe always noted for their kindly temper, received the new comers within their territory, and gave them a site for their town, which of course brought with it the hunting and fishing privileges necessary for their existence. The principal Cayuga villages were clustered about the lake to which the nation has given its name. South of them lay the land assigned to the Tuteloes. Their chief settlement, according to a careful observer, was on the east side of Cayuga inlet, about three miles from the south end of Cayuga lake, and two miles south of Ithaca. "The town was on the high ground south of the school-house, nearly opposite Buttermilk Falls, on the farm of James Fleming. On the Guy Johnson's map of 1771, it figures (by a slight misprint) as Todevigh-rono. It was called in the Journal of General Dearborn, Coreorgonel; in the Journal of George Grant (1779), Dehoriss-kanadia; and on a map made about the same date Kayeghtalagealat."*

The town was destroyed in 1779 by General Sullivan, in the expedition which avenged, so disastrously for the Six Nations, the ravages committed by them upon the settlements of their white neighbors. The result, as is well known, was the destruction of the ancient confederacy. Of the broken tribes, some fragments remained in their original seats, submitting to the conquerors. All the Mohawks, the greater part of the Cayugas, about half of the Onondagas, and many of the Oneidas, with a few of the Senecas and Tuscaroras, followed Brant to Canada. The British government furnished them with lands, mostly along the Grand River, in the territory which in ancient times had been conquered by the Iroquois from the people who were styled the Neutral Nation. The Tuteloes accompanied their friends the Cayugas. A place was found for them in a locality which seemed at the time attractive and desirable, but which proved most unfortunate for them. They built their town on a pleasant elevation, which stretches along the western bank of the Grand River, and still bears the name of Tutelo Heights. Under this name it now forms a suburb of the city of Brantford.

Fifty years ago, when the present city was a mere hamlet, occupied by a few venturous Indian traders and pioneers, the Tutelo cabins were scattered over these heights, having in the midst their "long-house" in which their tribal councils were held, and their festivals celebrated. They are said to have numbered then about two hundred souls. They retained apparently the reckless habits and love of enjoyment which had distinguished them in former times. Old people still remember the uproar of the dances which enlivened their council-house. Unhappily, the position of

*I am indebted for this and much other valuable information to my friend General John S. Clark, of Auburn, N. Y., who has made the location and migrations of the Indian tribes the subject of a special study. Of the above names Dehoriss kanadia is apparently a corruption of the Mohawk words *Tehotertgh kanada*, Tutelo town. The other words are probably, like most Indian names of places, descriptive designations, but are too much corrupted to be satisfactorily deciphered.

NIKONHA, THE LAST TUTELO.

IN 1870; AGED 106.

their town brought them into direct contact with the white settlements. Their frames, enfeebled by dissipation, were an easy prey to the diseases which followed in the track of the new population. In 1832, the Asiatic cholera found many victims on the Indian Reserve. The Tuteloes, in proportion to their numbers, suffered the most. The greater part of the tribe perished. Those who escaped clung to their habitations a few years longer. But the second visitation of the dreadful plague in 1848 completed the work of the first. The Tutelo nation ceased to exist. The few survivors fled from the Heights to which they have left their name, and took refuge among their Cayuga friends. By intermarriage with these allies, the small remnant was soon absorbed; and in the year 1870, only one Tutelo of the full blood was known to be living, the last survivor of the tribe of stalwart hunters and daring warriors whom Lawson encountered in Carolina a hundred and seventy years before.

This last surviving Tutelo lived among the Cayugas, and was known to them by the name of Nikonha. Okonha in the Cayuga dialect signifies mosquito. *Nikonha* was sometimes, in answer to my inquiries, rendered "mosquito," and sometimes "little," perhaps in the sense of mosquito-like. His Tutelo name was said to be Waskiteng; its meaning could not be ascertained, and it was perhaps merely a corruption of the English word mosquito. At all events, it was by the rather odd cognomen of "Old Mosquito," that he was commonly known among the whites; and he was even so designated, I believe, in the pension list, in which he had a place as having served in the war of 1812. What in common repute was deemed to be the most notable fact in regard to him was his great age. He was considered by far the oldest man on the Reserve. His age was said to exceed a century; and in confirmation of this opinion it was related that he had fought under Brant in the American war of Independence. My friend, Chief George Johnson, the government interpreter, accompanied us to the residence of the old man, a log cabin, built on a small eminence near the centre of the Reserve. His appearance, as we first saw him, basking in the sunshine on the slope before his cabin, confirmed the reports which I had heard, both of his great age and of his marked intelligence. "A wrinkled, smiling countenance, a high forehead, half-shut eyes, white hair, a scanty, stubbly beard, fingers bent with age like a bird's claws," is the description recorded in my note-book. Not only in physiognomy, but also in demeanor and character, he differed strikingly from the grave and composed Iroquois among whom he dwelt. The lively, mirthful disposition of his race survived in full force in its latest member. His replies to our inquiries were intermingled with many jocose remarks, and much good-humored laughter.

He was married to a Cayuga wife, and for many years had spoken only the language of her people. But he had not forgotten his proper speech, and readily gave us the Tutelo renderings of nearly a hundred words. At that time my only knowledge of the Tuteloes had been derived from the few notices comprised in Gallatin's Synopsis of the Indian Tribes, where

they are classed with the nations of the Huron-Iroquois stock. At the same time, the distinguished author, with the scientific caution which marked all his writings, is careful to mention that no vocabulary of the language was known. That which was now obtained showed, beyond question, that the language was totally distinct from the Huron-Iroquois tongues, and that it was closely allied to the languages of the Dacotan family.

The discovery of a tribe of Dakota lineage near the Atlantic coast was so unexpected and surprising that at first it was natural to suspect some mistake. The idea occurred that the old Tutelo might have been a Sioux captive, taken in the wars which were anciently waged between the Iroquois and the tribes of the far West. With the view of determining this point, I took the first opportunity, on my next visit to the Reserve, in October, 1870, of questioning the old man about his early history, and that of his people. His answers soon removed all doubt. He believed himself to be a hundred and six years old; and if so, his earliest recollections would go back to a time preceding by some years the Revolutionary war. At that time his people, the Tuteloes, were living in the neighborhood of two other tribes, the Saponies and the Patshenins or Botshenins. In the latter we may perhaps recognize the Ochineeches, whom Governor Spotteswood, in 1702, enumerated with the Saponies, Toteroes, and two other tribes, under the general name of Christanna Indians. The Saponies and Tuteloes, old Nikonha said, could understand one another's speech. About the language of the Patshenins, I neglected to inquire, but they were mentioned with the Saponies as a companion tribe. When the Tuteloes came to Canada with Brant, they parted with the Saponies at Niagara Falls, and he did not know what had become of them. His father's name was Onusōwa; he was a chief among the Tuteloes. His mother (who was also a Tutelo), died when he was young, and he was brought up by an uncle. He had heard from old men that the Tuteloes formerly lived on a great river beyond Washington, which city he knew by that name. In early times they were a large tribe, but had wasted away through fighting. Their war parties used to go out frequently against various enemies. The tribes they most commonly fought with were the Tuscaroras, Senecas, and Cayugas. Afterwards his tribe came to Niagara (as he expressed it), and joined the Six Nations. He knew of no Tutelo of the full blood now living, except himself.

This, with some additions to my vocabulary, was the last information which I received from old Waskiteng, or Nikonha. He died a few months later (on the 21st of February, 1871), before I had an opportunity of again visiting the Reserve. There are, however, several half-castes, children of Tutelo mothers by Iroquois fathers, who know the language, and by the native law (which traces descent through the female) are held to be Tuteloes. One of them, who sat in the council as the representative of the tribe, and who, with a conservatism worthy of the days of old Sarum, was allowed to retain his seat after his constituency had disappeared, was

accustomed to amuse his grave fellow-senators occasionally by asserting the right which each councillor possesses of addressing the council in the language of his people,—his speech, if necessity requires, being translated by an interpreter. In the case of the Tutelo chief the jest, which was duly appreciated, lay in the fact that the interpreters were dumfounded, and that the eloquence uttered in an unknown tongue had to go without reply.

From this chief, and from his aunt, an elderly dame, whose daughter was the wife of a leading Onondaga chief, I received a sufficient number of words and phrases of the language to give a good idea of its grammatical framework. Fortunately, the list of words obtained from the old Tutelo was extensive enough to afford a test of the correctness of the additional information thus procured. The vocabulary and the outlines of grammar which have been derived from these sources may, therefore, as far as they extend, be accepted as affording an authentic representation of this very interesting speech.

There is still, it should be added, some uncertainty in regard to the tribal name. So far as can be learned, the word Tutelo or Totero (which in the Iroquois dialects is variously pronounced Tiũterih or Tehōtirigh, Tehũtili, Tiũtei and Tũtie) has no meaning either in the Tutelo or the Iroquois language. It may have been originally a mere local designation, which has accompanied the tribe, as such names sometimes do, in its subsequent migrations. Both of my semi-Tutelo informants assured me that the proper national name—or the name by which the people were designated among themselves—was Yesáng or Yesáh, the last syllable having a faint nasal sound, which was sometimes barely audible. In this word we probably see the origin of the name, Nahyssan, applied by Lederer to the tribes of this stock. John Lederer was a German traveler who in May, 1670—a year before Captain Batt's expedition to the Alleghenies—undertook, at the charge of the colonial government, an exploring journey in the same direction, though not with equal success. He made, however, some interesting discoveries. Starting from the Falls of the James river, he came, after twenty days of travel, to "Sapon, a village of the Nahyssans," situate on a branch of the Roanoke river. These were, undoubtedly, the Saponas whom Captain Batt visited in the following year, the kindred and allies of the Tuteloes. Fifty miles beyond Sapon he arrived at Akenatzy, an island in the same river. "The island," he says, "though small, maintains many inhabitants, who are fixed in great security, being naturally fortified with fastnesses of mountains and water on every side."* In these Akenatzies we undoubtedly see the Aconechos of Lawson, and the Ochineeches mentioned by Governor Spotteswood. Dr. Brinton, in his well-known work on the "Myths of the New World," has pointed out, also, their identity with the Occaneeches mentioned by Beverley in his "History of Virginia," and in doing so has drawn attention to

* See "*The Discoveries of John Lederer*," reprinted by O. H. Harpel. Cincinnati, 1879, p. 17.

the very interesting facts recorded by Beverley respecting their language.*

According to this historian, the tribes of Virginia spoke languages differing so widely that natives "at a moderate distance" apart did not understand one another. They had, however, a "general language," which people of different tribes used in their intercourse with one another, precisely as the Indians of the north, according to La Hontan, used the "Algonkine," and as Latin was employed in most parts of Europe, and the Lingua Franca in the Levant. These are Beverley's illustrations. He then adds the remarkable statement: "The general language here used is that of the Occaneeches, though they have been but a small nation ever since these parts were known to the English; but in what their language may differ from that of the Algonkins I am not able to determine."† Further on he gives us the still more surprising information that this "general language" was used by the "priests and conjurors" of the different Virginian nations in performing their religious ceremonies, in the same manner (he observes) "as the Catholics of all nations do their Mass in the Latin."‡

The Akenatzies or Occaneeches would seem to have been, in some respects, the chief or leading community among the tribes of Dakotan stock who formerly inhabited Virginia. That these tribes had at one time a large and widespread population may be inferred from the simple fact that their language, like that of the widely scattered Algonkins (or Ojibways) in the northwest, became the general medium of communication for the people of different nationalities in their neighborhood. That they had some ceremonial observances (or, as Beverley terms them, "adorations and conjurations") of a peculiar and impressive cast, like those of the western Dakotas, seems evident from the circumstance that the intrusive tribes adopted this language, and probably with it some of these observances, in performing their own religious rites. We thus have a strong and unexpected confirmation of the tradition prevailing among the tribes both of the Algonkin and of the Iroquois stocks, which represents them as coming originally from the far north, and gradually overspreading the country on both sides of the Alleghanies, from the Great Lakes to the mountain fastnesses of the Cherokees. They found, it would seem, Virginia, and possibly the whole country east of the Alleghenies, from the Great Lakes to South Carolina, occupied by tribes speaking languages of the Dakotan stock. That the displacement of these tribes was a very gradual process, and that the relations between the natives and the encroaching tribes were not always hostile, may be inferred not only from the adoption of the aboriginal speech as the general means of intercourse, but also from the terms of amity on which these tribes of diverse origin, native and intrusive, were found by the English to be living together.

* See the note on page 303 of Dr Brinton's volume, 2d edition.

† History of Virginia (1st edition), p. 161.

‡ *Ibid.*, p. 171.

That the Tutelo tongue represents this "general language" of which Beverley speaks—this aboriginal Latin of Virginia—cannot be doubted. It may, therefore be deemed a language of no small historical importance. The fact that this language, which was first obscurely heard of in Virginia two hundred years ago, has been brought to light in our day on a far-off Reservation in Canada, and there learned from the lips of the latest surviving member of this ancient community, must certainly be considered one of the most singular occurrences in the history of science.

Apart from the mere historical interest of the language, its scientific value in American ethnology entitles it to a careful study. As has been already said, a comparison of its grammar and vocabulary with those of the western Dakota tongues has led to the inference that the Tutelo language was the older form of this common speech. This conclusion was briefly set forth in some remarks which I had the honor of addressing to this Society at the meeting of December 19, 1879, and is recorded in the published minutes of the meeting. Some years afterwards, and after the earlier portion of this essay was written, I had the pleasure, at the meeting of the American Association for the Advancement of Science, held in Montreal, in September, 1882, of learning from my friend, the Rev. J. Owen Dorsey, of the Smithsonian Institution, who has resided for several years as a missionary among the western Dakotas, and has made careful researches into their languages and history, that they have a distinct tradition that their ancestors formerly dwelt east of the Mississippi. In fact, the more southern Dakotas declare their tribes to be offshoots of the Winnebagoes, who till recently resided near the western shore of Lake Michigan. A comparison of their dialects, made with Mr. Dorsey's aid, fully sustains this assertion. Mere traditionary evidence, as is well known, cannot always be relied on; but when it corresponds with conclusions previously drawn from linguistic evidence, it has a weight which renders it a valuable confirmation.

The portrait of old Nikonha, an accurate photograph, will serve to show, better than any description could do, the characteristics of race which distinguished his people. The full oval outline of face, and the large features of almost European cast, were evidently not individual or family traits, as they reappear in the Tutelo half-breeds on the Reserve, who do not claim a near relationship to Nikonha. Those who are familiar with the Dakotan physiognomy will probably discover a resemblance of type between this last representative of the Virginian Tutelos and their congeners, the Sioux and Mandans of the western plains.

THE TUTELO LANGUAGE.

In the following outline of Tutelo grammar, it has been deemed advisable to bring its forms into comparison with those of the western languages of the same stock. For this purpose the Dakota and Hidatsa (or Minnetaree) languages were necessarily selected, being the only tongues of this family of which any complete account has yet been published.

For the information respecting these languages I am indebted to the Dakota Grammar and Dictionary of the Rev. S. R. Riggs (published in the Smithsonian Contributions to Knowledge) and the Hidatsa Grammar and Dictionary of Dr. Washington Matthews (published in Dr. Shea's Library of American Linguistics), both of them excellent works, of the highest scientific value.

The Alphabet.

The alphabetical method which has been followed by me in writing this language, as well as the Iroquois dialects, is based on the well-known system proposed by the Hon. John Pickering, and generally followed by American missionaries, whose experience has attested its value. The modifications suggested for the Indian languages by Professor Whitney and Major Powell have been adopted, with a few exceptions, which are due chiefly to a desire to employ no characters that are not found in any well-furnished printing-office.

The letters *b, d, h, k, l, m, n, p, s, t, w, y, z* are sounded as in English, the *s* having always its sharp sound, as in *mason*. The vowels are sounded generally as in Italian or German, with some modifications expressed by diacritical marks, thus:

a, as in *father;* in accented syllables written *ā*.
ă, like the German *a* in *Mann.*
ä, like *a* in *mat.*
â, like *a* in *fall.*
e, like *a* in *fate;* in accented syllables *ē*.
ĕ, like *e* in *met.*
i, like *i* in *machine;* in accented syllables *ī*.
ĭ, like *i* in *pin.*
o, as in *note;* in accented syllables *ō*.
ŏ, like the French *o* in *bonne.*
ò, like *o* in *not.*
ú, as in *rule*, or like *oo* in *pool;* in accented syllables *ū*.
ŭ, like *u* in *pull,*
ù, like *u* in *but;* in an accented syllable written *û*.
ü, like the French *u* in *dur.*

The diphthongs are, *ai*, like our long *i* in *pine;* *au*, like *ou* in *loud;* *âi*, like *oi* in *boil;* *iu*, like *u* in *pure.*

The consonants requiring special notice are:

ç, like *sh* in *shine.*
g, always hard, as in *go, get, give.*
j, like *z* in *azure.*
ñ, like the French nasal *n* in *an, bon, un.*
q, like the German *ch* in *Loch*, or the Spanish *j* in *joven*

The sound of the English *ch* in *chest* is represented by *tç;* the *j* and *dg* in *judge* by *dj*.

The apostrophe (') indicates a slight hiatus in the pronounciation of a word, which is often, though not always, caused by the dropping of a consonantal sound.

In general, the diacritical marks over the vowels are omitted, except in the accented syllable—that is, the syllable on which the stress of voice falls. It is understood that when a vowel (other than the *ù*) has a mark of any kind over it, the syllable in which it occurs is the accented or emphatic syllable of the word. Experience shows that the variations in the sound of a vowel in unaccented syllables, within the limits represented by the foregoing alphabet, are rarely of sufficient importance to require to be noted in taking down a new language. The only exception is in the sound marked *ù*, which occasionally has to be indicated in unaccented syllables, to distinguish it from the *u*, with which it has no similarity of sound. It is, in fact, more frequently a variation of the *a* than of any other vowel sound.

Occasionally the accented syllable is indicated by an acute accent over the vowel. This method is adopted principally when the vowel has a brief or obscure sound, as in *misáñi*, I alone, which is pronounced in a manner midway between *misāñi* and *misùñi*.

Phonology.

The Tutelo has the ordinary vowel sounds, but the distinction between *e* and *i*, and between *o* and *u* is not always clear. The word for "mother" was at one time written *henā*, and at another *ina;* the word for "he steals" was heard as *manōma* and *manūma*. In general, however, the difference of these vowels was sufficiently apparent. The obscure sound of *ù* (or in accented syllables *û*) was often heard, but when the word in which it occurred was more distinctly uttered, this sound was frequently developed into a clearer vowel. Thus *hùstōi*, arm, became *histō ; mùstē*, spring (the season), became *mastē ; asûñi*, white, became *asāñi*, or (losing the nasal sound) *asāi*, and so on. The use of the character *ù* (or *û*) in this language could probably be dispensed with.

The consonantal sounds which were heard were: *p* (or *b*), *t* (or *d*), *k* (or *g*), *h* (and *q*), *l*, *m*, *n*, *s*, *w* and *y*, and the nasal *ñ*. Neither *f*, *v*, nor *r* was heard, and *ç* (*sh*) only as a variant of *s*. Harsh combinations of consonants were rare. The harshest was that of *tsk*, as in *wagutska*, child, and this was not frequent.* Words usually end in a vowel or a liquid. A double con-

* In *wagutska* (Dakota, *koçka*), *suntka*, younger brother (Dak., *sunka*); *tçoñgo* or *tçuñki*, dog (Dak., *cuñka*) and many similar words, the *t* is apparently an adscititious sound, inserted by a mere trick of pronunciation. The Hidatsa carries this practice further, and constantly introduces the sound of *t* before the sharp *s*. The Tutelo *isi*, foot, becomes *itsi* in Hidatsa; *sani*, cold, becomes *tsinia*, &c

sonant at the commencement of a word is rare. It perhaps only occurs in the combination *tç* (*tsh*) and in contractions, as *ksãñkai*, nine, for *kasãñkai*.

It is doubtful if the sonants *b*, *d* and *g* occur, except as variants of the surd consonants *p*, *t* and *k*; yet in certain words sonants were pretty constantly used. Thus in the pronouns *miñgitowe*, mine, *yiñgitowe*, thine, *iñgitowe*, his, the *g* was almost always sounded.

The *l* and *n* were occasionally interchanged, as in *lãni* and *nãni*, three, *letçi* and *netçi*, tongue. In general, however, the two elements seemed to be distinct. The aspirate was somewhat stronger than the English *h*, and frequently assumed the force of the German *ch* or the Spanish *j* (represented in our alphabet by *q*). Whether there were really two distinct sounds or not, could not be positively ascertained. The same word was written at one time with *h*, and at another with *q*.

The nasal *ñ* is properly a modification of the preceding vowel, and would have been more adequately rendered by a mark above or below the vowel itself; but it has seemed desirable to avoid the multiplication of such diacritical marks. This nasal is not to be confounded with the sound of *ng* in *ring*, which is a distinct consonantal element, and in the Polynesian dialects often commences a word. In the Tutelo this latter sound only occurs before a *k* or hard *g*, and is then represented by *ñ*. It is, in fact, in this position, merely the French nasal sound, modified by the palatal consonant. The nasal *ñ* is also modified by the labials *b* and *p*, before which it assumes the sound of *m*. Thus the Tutelo word for day, *nahãmbi*, or (in the construct form) *nahãmp*, is properly a modification of *nahãñbi* or *nahãñp*. In all words in which it occurs, the nasal sound was at times very faintly heard, and was occasionally so little audible that it was not noted, while at other times an *n* was heard in its place. The word for knife was written at different times *masẽñi* and *masãi*; that for sky, *matõñi*, *matõi*, *mantõi*, and *mañtoi*; that for day, *nahãmbi*, *nahãmp*, *nahãñp*, and *nahãp*; that for winter, *wãnẽ*, *wãnẽñi*, and *wanẽi*; that for one, *nõs* and *noñs*, and so on. Whether this indistinctness of the nasal sound belongs to the language, or was a peculiarity of the individuals from whom the speech was learned, could not be satisfactorily determined.

The tendency of the language, as has been said, is to terminate every word with a vowel sound. When a monosyllable or dissyllable ends with a consonant, it is usually in a construct form, and is followed by another word grammatically related to it. Thus, *hisépi*, axe, *hisẽp miñgitowe*, my axe; *monti*, a bear, *mont nosã*, one bear; *tçõñgo* (or *tçònki*), dog, *tçònk episel*, good dog; *nahãmbi*, day, *nahãmp lãni*, three days.

The following brief comparative list, extracted from the more extensive vocabulary hereafter given, will show the forms which similar words take in the allied dialects, Tutelo, Dakota (or Sioux proper) and Hidatsa (or Minnetaree):

Tutelo.	Dakota.	Hidatsa.	
āti	*ate*	*ati*	father
īnā, henā, henûñ	*ina*	*hinu, hu, ikûs*	mother
tāyû!çkai	*takoçku, tçiñkçi*	*idiçi*	son
suntka	*suñka*	*tsuka*	younger brother
īh, ihī	*i*	*i*	mouth
nē!çi, nētsi, lē!çi	*tçeji*	*neji*	tongue
ihī	*hi*	*i, isa, hi*	tooth
lōti	*dote*	*doti, loti*	throat
isī	*siha*	*itsi*	foot
wasūt	*nasu*	*tsuata*	brain
wāyī, wayīi	*we*	*idi*	blood
atī	*tipi*	*ati*	house
maséñī, masāi	*isañ, miñna*	*maetsi*	knife
mī	*wi*	*midi*	sun (or moon)
nihāmpi, nihāñpi	*añpetu*	*mape*	day
manī	*mini*	*mini*	water
amāñi, amāi	*maka*	*ama*	land
tcūñki, tçoñgo	*çunka*	*maçuka*	dog
wānéñi, wānēi	*wani*	*mana*	winter
tañi	*ptañ*	*mata,*	autumn
asáñi, asāi, aséi	*sañ*	*átùki, ohùki*	white
asépi	*sapa*	*çipi*	black
sīi, wāsi	*zi*	*tsi, tsidi*	yellow
tē	*ta*	*te*	dead
sani	*sni*	*tsinia*	cold
nosāi, noñç	*wantça, wantçi*	*nuéts, luétsa*	one
nombāi	*noñpa*	*nopa*	two
nāni, lāni	*yamni*	*dámi, lawi*	three
topai	*topa*	*topa*	four
kisāhai	*zaptañ*	*kihu*	five
akáspe	*çakpe*	*akama, akawa*	six
sāgomink	*çakowiñ*	*sapua*	seven
luta	*yuta, wota*	*duti*	to eat
howa	*u, uwa*	*hu*	to come
kitci	*watçi*	*kidiçi*	to dance
mahanañka	*yañka, nañka*	*naka*	to sit, remain
ktéwa, kitésel	*kte*	*kitahé*	to kill

It must be borne in mind that the sounds of *m*, *b*, and *w* are interchangeable in the Hidatsa, and that *d*, *l*, *n*, and *r* are also interchangeable. A similar confusion or interchange of these elements is to some extent apparent in the Dakota and the Tutelo languages. Taking this fact into consideration, the similarity or rather identity of such words as *mi* in Tutelo and *wi* in Dakota, meaning "sun," and *loti* in Tutelo, *dote* in Dakota, and *dote* or *lote* in Hidatsa, meaning "brain," becomes apparent.

The nasal sounds, which are so common in the Dakota and the Tutelo, are wanting in the Hidatsa, while the *s* of the two former languages frequently becomes *ts* in Hidatsa. These dialectical peculiarities explain the difference between the words for younger brother, *suntka*, Tu., *suñka*, Da., *tsuka*, Hi., between *isi*, foot, Tu., and *itsi*, Hi., between *maseñi*, knife, Tu., and *maetsi*, Hi. It will be noticed that the words in Tutelo are frequently longer and fuller in sound than the corresponding words in the other languages, as though they were nearer the original forms from which the words in the various Dakota tongues were derived.

Grammatical Forms.

As is usually the case with allied tongues, the grammatical resemblances of the languages of this stock are much more striking and instructive than those which appear in the mere comparison of isolated words.

Substantives and Adjectives.

The Tutelo, like the Dakota and the Hidatsa, has no inflection of the substantive to indicate the plural number; but in both the Tutelo and the Dakota, the plural of adjectives is frequently expressed by what may be termed a natural inflection, namely, by a reduplication. In the Dakota, according to Mr. Riggs, the initial syllable is sometimes reduplicated, as *ksapa*, wise, pl. *ksaksapa; tañka*, great, pl. *tañktañka;* sometimes it is the last syllable, as *waçté*, good, pl. *waçtéçte;* and occasionally it is a middle syllable, as, *tañkiñyañ*, great, pl. *tañkiñkiñyañ*.

Sometimes the adjective in Dakota takes the suffix *pi*, which makes the plural form of the verb, as *waçté*, good *wiçasta waçtépi*, good men, *i. e.*, they are good men.

Similar forms exist in the Tutelo. The adjective, or some part of it, is reduplicated in the plural, and at the same time a verbal suffix is frequently if not always added, thus; *ati api*, good house, pl. *ati apipisel*, good houses (those are good houses); *ati itáñi*, large house, pl. *ati itañtáñsel; ati okayēke*, bad house, pl. *ati okayeyēkesel; ati asáñ*, white house, pl. *ati asañsáñsel.*' Occasionally the reduplication takes a peculiar form, as in *ati kutska*, small house, pl. *ati kotskutskaisel*. In one instance the plural differs totally from the singular; *ati sui*, long house, pl. *ati yumpañkatskaisel.*

The plural verbal termination is frequently used without the reduplication; as, *wahtáke bi* (or *pi*), good man, *wahtáke biwa* (or *bise*), he is a good man; pl. *wahtáke bihla* (or *bihlése*), they are good men. So *tçoñje bise*, good dog (or, it is a good dog), pl. *tçoñje bihlése.*

The plural form by reduplication does not appear to exist in the Hidatsa.

The Rev. J. Owen Dorsey, who has made a special study of the western Dakota languages, finds in the Omaha (or Dhegiha) dialect a peculiar meaning given to this reduplicate plural of adjectives. The following ex-

amples will illustrate this signification. *Jiñgā*, small, becomes in the reduplicate form *jiñjiñga*, which refers to small objects of different kinds or sizes. *Sagi*, firm, fast, hard, makes *sāsagi* or *sagiji*, which is employed as in the following example: *vedhihide sagigihnan kañbdha*, I wish tools that are hard, and of different kinds, them only. Here the suffix *hnān* expresses the meaning of "only;" the reduplication of the adjective gives the sense expressed by the words "of different kinds." *Sābe*, black, makes *sāsabe*, black here and there. *Gdhejē*, spotted, becomes *gdhegāja* spotted in many places. *Piaji*, bad, makes *pipiaji*, as in *uçkañ pipiaji*, different bad deeds. *Nūjiñga* (apparently a compound or derivative form, from *jiñgā*, small), means "boy," *i. e.*, small man; *nūjiñjiñga*, boys of different sizes and ages.* It would seem from these examples that in this language the reduplication expresses primarily the idea of variety, from which that of plurality in many cases follows. This meaning is not indicated by Mr. Riggs in his Dakota grammar, and it was not detected by me in the Tutelo, but it is not impossible that it actually exists in both languages. It is deserving of notice that while no inflection of the noun is found in the Iroquois to express plurality, this meaning is indicated in the adjective by the addition of *s*, or *hoñs*, affixed to the adjective when it is combined with the noun. Thus from *kanóñsa*, house, and *uiyo*, handsome, we have *kanoñsiyo*, handsome house, pl. *kanoñsiyos*, handsome houses. So *kareñnaksen*, bad song, pl. *kareñnaksens*, bad songs; *kanākares*, long pole, pl. *kanakarēshoñs*, long poles.

It is also remarkable that the peculiar mode of forming the plural, both of substantives and of adjectives, by reduplication of the first syllable or portion of the word, is found in several Indian languages spoken west of the Rocky Mountains, and belonging to families entirely distinct from one another, and from the Dakota. Thus in the Selish language we have *lùáus*, father, pl. *lùlùáus*; *tána*, ear, pl. *tùntána*; *skùltamiqo*, man, pl. *skùlkùltamiqo*; *qáest*, good, pl. *qùsqáest*. In the Sahaptin, *pitin*, girl, pl. *pipitin*; *tāhs*, good, pl. *titāhs*. In the Kizh language, *woróit*, man, pl. *wororōt*; *tçinni*, small, pl. *tçitçinni*.† This has been termed, and certainly seems, a natural mode of forming the plural. It is therefore somewhat surprising to find it restricted in America to a comparatively small group of linguistic families. It is still more noteworthy that in the Polynesian dialects, which in their general characteristics differ so widely from the Indian languages, this same method of forming the plural is found, but confined, as in the Dakota tongues, to the adjective; thus we have *laau tele*, large tree, pl. *laau tetele*, large trees; *taata maitai*, good man, pl. *taata maitatai*, good men; *mahaki*, sick, pl. *mahamahaki*, sick (persons).‡ This is a subject in linguistic science which merits further investigation.

* I am indebted to Mr. Dorsey's letters for this and much other information of great interest respecting the western languages of the Dakota stock, forming part of his extensive work, which we may hope will soon be published.

† Ethnography and Philology of the U. S. Exploring Expedition under Chas. Wilkes, pp. 534, et seq.

‡ *Ibid.*, p. 244.

Numerals.

The near resemblance of the first seven numerals in the Tutelo, Dakota, and Hidatsa is sufficiently shown in the vocabulary. The manner in which the compound numbers are formed is also similar in the three languages. In the Dakota *ake*, again, is prefixed to the simple numerals to form the numbers above ten, as *ake wañjidañ*, eleven; *ake noñpa*, twelve. In the Tutelo the same word (usually softened to *age*) is used, as *agenōsai*, eleven; *agenombai*, twelve. In the Hidatsa *aqpi* (or *ahpi*), signifying a part or division, is employed, as *aqpi-duetsa*, eleven; *aqpi-dopa*, twelve.

In Dakota, *wiktçemna*, ten, and *noñpa*, two, form *wiktçemna noñpa*, twenty. In Tutelo the form is the same; *putçka nomba*, tens-two. In Hidatsa it is similar, but the position of the words is reversed, twenty being *dopá-pitika*, two tens.

The ordinal numbers, after the first, are formed in all three languages by prefixing *i* or *ei* to the cardinal numbers, as in Dakota, *inoñpa*, second; *iyamni*, third; *itopa*, fourth. In Hidatsa, *idopa*, second; *idani*, third; *itopa*, fourth. In Tutelo I received *einombai*, twice; *eināni*, thrice; *eintōpai*, four times. This rendering was given by the interpreter, but the true meaning was probably the same as in the Dakota and Hidatsa. The word for "first" is peculiar in all three languages; in Dakota, *tokaheya*, in Hidatsa, *itsika*, in Tutelo, *etāhni*.

In the Tutelo the numerals appear to have different forms; or perhaps, more accurately speaking, different terminations, according to the context in which they are used. The following are examples of these forms, the first or abridged form being apparently used in ordinary counting, and the others when the numerals are employed in conjunction with other words. The various pronunciations of my different informants—and sometimes of the same informant at different times—are also shown in these examples.

	Separate.	Construct.	Variations.
1	*nōñs*, *nōs*	*nosāi*, *neñsāi*	*noséñ*, *nuseñ*, *noñsai*, *noñsa*, *nōsāñ*, *nōsāh*, *noñsah*
2	*nomp*	*nombāi*	*numbāi*, *nomba*, *nūmba*, *noñmbai*, *noñpa*, *nōmbāh*, *nombaq*
3	*lāt*, *nān*	*nāni*	*lāni*, *lānih*, *lāniq*
4	*tōp*	*topāi*	*toba*, *topah*
5	*kisē*, *kisāñ*	*kisāhai*	*kisāhāñi*
6	*agās* or *akás*, *akāsp*	*akáspē*	*akaspé*, *akāspei*, *agespeq*
7	*sāgóm*	*sagomēi*	*sagōmi*, *sāgōmiq*, *sagomīñk*
8	*pālán*	*palāni*	*palāniq*
9	*sā* or *sāñ*, *ksañk*	*ksāhkai*	*kasankai*, *ksākai*
10	*putçk*, *būtçk'*	*putskai*	*butçkai*, *putskāñi*, *putskāñ*
11	*āgenōsai*		*aginosai*, *akinosai*

	Separate.	Construct Forms and Variations.
12	*agenomba*	*aginombai, akinombai*
13	*agelani*	*agilāli, akilāni*
14	*agetoba*	*akitōpa*
15	*agegīsai*	*akikisāhai*
16	*agegāspe*	*akikaspei*
17	*agesagōmi*	*akisagomei*
18	*agepalāni*	*akipalali*
19	*agekesañka*	*akikasañkai*
20	*putska nomba, putçka nombai*	*putska nombai*
30	*putska nani*	*putçka lani*
40	*putska tobai*	
100	*ukenī nōsā*	*okenī*
1000	*ukenī putskai*	

The numeral follows the noun which it qualifies. If the noun terminates in a vowel not accented, the vowel is usually dropped, while the numeral assumes its constuctor or lengthened form, and is sometimes closed with a strong aspirate. Thus, from *mihā́ñi*, woman, we have *mihañ nosā* or *mihañ noñsāi*, one woman; *mihañ nombaq*, two women; *mihañ laniq*, three women, &c. From *tçoñ,jo* or *tçoñki*, dog, *tcoñk nosāh*, one dog; *tcoñk nombaq*, two dogs. From *monti*, bear, *mont nōsāh*, one bear; *mont nombah*, two bears. From *nahambi*, day, *nahámp nosāh*, one day, *nahamp nombai*, two days; *nahamp lāniq*, three days, &c. It will be seen that the dropping of the final vowel of the noun has the effect of giving a sharper sound to the preceding consonant. When the final vowel is accented, no change takes place in the noun; thus *atī*, house; *atī noñsai*, one house; *atī noñbai*, two houses; *atī laniq*, three houses, &c.

No such difference between the simple and the construct forms of the numerals appears to exist either in the Dakota or in the Hidatsa. This is one evidence, among others, of the greater wealth of inflections which characterizes the Tutelo language.

Pronouns.

There are in the Tutelo, as in the Dakota, two classes of pronouns, the separate pronouns, and the affixed or incorporated pronouns. The former, however, are rarely used, except for the purpose of emphasis. In the Dakota the separate pronouns are *miye* or *miç*, I, *niye*, or *niç*, thou or ye, *iye*, or *iç*, he or they, and *uñkiye* or *uñkie*, we. In the Tutelo, *mīm* signifies I or we, *yīm*, thou or ye, *im*, he or they, which was sometimes lengthened to *imahēse*. A still more emphatic form is made with the termination *sái* or *sáñi*, giving the sense of "alone," or rather perhaps

"self," for which meaning the Dakota employs the separate pronouns already given, while the Hidatsa has a special form ; thus :

Tutelo.	Dakota.	Hidatsa.	
misāi or *misáñi*	*miye* (*miç*)	*miqki*	I myself (or I alone)
yisāi, or *yesáñi*	*niye* (*niç*)	*niqki*	thou
esāi, *isāi* or *isáñi*	*iye* (*iç*)	*iqki*	he
maesāi or *maesáñi*	*uñkiye* (*uñkiç*)	*midoki*	we

The Dakota *uñkiye* is said to be properly a dual form. The Tutelo apparently, like the Hidatsa, has no dual.

The affixed or incorporated pronouns have in the Tutelo, as in the Dakota and Hidatsa, two forms, nominative and objective. These forms in the three languages are very similar :

Tutelo.	Dakota.	Hidatsa.	
	Nominative.		
ma, *wa*	*wa*, *we*	*ma*	I
ya, *ye*	*ya*, *ye*	*da* (*na*)	thou
mae, *mai*, *wae*, *wai*, *man*, *mañk*,	*uñ*		we
	Objective.		
mi, *wi*	*ma*, *mi*	*mi*	me
yi, *hi*	*ni*	*di* (*ni*)	thee
e, *ei*, *i*		*i*	him
mae, *mai*, *wae*, *wai*	*uñ*		us

The objective forms are also used in all these languages as possessive pronouns, and they are affixed as nominatives to neuter or adjective verbs, in the first and second persons. The third personal pronoun is not expressed in the verb, at least in the singular number. In the plural the Tutelo indicates this pronoun by an inflection, both in the nominative and the objective. Thus *hahēwa*, he says, *hahéhla*, they say ; *minēwa*, I see him, *minéhla*, I see them.

The Hidatsa makes no distinction between the singular and the plural of the possessive pronouns. *Mi* signifies both my and our, *di*, they and your, and *i*, his and their. The Dakota distinguishes the plural by adding the particle *pi* to the noun. The Tutelo adds *pui* to the noun in the second person, and sometimes *lei* or *kai* to the third. With nouns signifying relationship, the Dakota indicates the possessive pronoun of the third person by adding *ku* to the noun. The Tutelo sometimes adds *ka* or *kai* not only in this person, but in the first and third persons, as shown in the following example :

Dakota.	Tutelo.		
suñka	*súntka*		younger brother
misuñka	*wisúntk*	my	" "
yisuñka	*yisúntk*	thy	" "
suñkaku	*esúntka* or *esúntkai*	his	" "
uñkisuñkapi	*maisúñtkai*	our	" "
nisuñkapi	*yisúñtkapui*	your	" "
suñkapi	*eisúñtkai*	their	" "

In the Tutelo an *e* is sometimes prefixed to the possessive pronouns, as in *ati*, house, which makes

ewāti	my house	*emānti*	our house
eyāti	thy "	*eyātipūi*	your "
eāti	his "	*eāti-lei*	their "

In this case the final vowel of the pronouns *wi* and *yi* is elided before the initial *a* of the noun. So in *minēwa*, I see him, the vowel of the prefixed pronoun *ma*, I, is elided before the vowel of the verb *inēwa*, to see. Some other euphonic changes of the possessive pronoun in the Tutelo are shown in the following example:

Dakota.	Tutelo.	
pa	*pasūi*,	head
mapa	*mimpasūi*,	my head
nipa	*yiñpasūi*,	thy "
pa	*epasūi*,	his "
uñpapi	*emañkpasūi*,	our heads
nipapi	*eyiñkpasūpui*	your "
papi	*epasūi-lei*	their "

In Tutelo, *tāt'*, my father, is an anomalous form, used instead of *māt'*, or *emāt'*. With the other affixes the word becomes *yāt'* (or *itāti*), thy father, *eāt'*, his father (or their father), *emaāt'*, our father, *eyātpui*, your father.

A good example of the use of the prefixed personal pronouns in the Tutelo is shown in the word for son. There were slight differences in the forms received from two of my informants, as here given:

witēka	*witēkai*	my son
yitēka	*yitēkai*	thy son
etēka	*etēkai*	his son
mañktēka	*emañktēkai*	our son
yitēkabūi	*yitēkabūi*	your son
etēka	*etekahlēi*	their son

Minēk', my uncle (in Dakota *midekçi*) is thus varied: *Yinēk'*, thy uncle (Dak. *nidekçi*), *einēk'*, his uncle (Dak. *deçitku*), *emainek*, our uncle, *einēkpui*, your uncle, *einek'* or *einek'-lei*, their uncle.

In the word for brother, *iñjinumbāi* (or *iñkinumbāi*), the possessive pronouns are inserted after the first syllable, and in this instance they are used in the nominative form:

iñwaginumbāi	my brother	*maiiñjinumbāi*	our brother
iñyagnumbāi	thy brother	*iñyaginumbabūi*	your brother
ingiginumbāi	his brother	*iñjiginumbāi*	their brother

The Dakota and Hidatsa have lengthened forms of the personal pronouns to indicate property in things, or "transferable possession." These are in the former, *mita*, my, *nita*, thy, and *ta*, his, as *mita-oñspe*, my axe, *nita-çuñke*, thy dog. These pronouns are also used with *koda*, friend, and *kitçuna*, comrade. In Hidatsa *mata*, *dita* (for *nita*), and *ita*, are used in a similar manner. In the Tutelo the pronouns of this form occurred in a

few examples, but only with certain words of personal connection or relations, in which their use seems to resemble that of the Dakota pronouns with the words meaning "comrade" and "friend." Thus we heard *witāmañki*, my husband, *yitāmañki*, thy husband, *etāmañki*, her husband. So *witāmiheñ*, my wife (*i. e.* my woman), *yitāmiheñ*, thy wife; and *witagūtçkāi*, my son, *i. e.* "my boy," from *wagūtçkāi*, boy (evidently the same word as the Dakota *koçka*, young man). In the latter example *witagūtçkāi*, apparently expresses a lower bond or sense of relationship than *witékai*,—not "my child," but "my boy," or "my youth," who may leave me and go elsewhere at any time.

In Tutelo the pronouns indicating property or "transferable possession" were commonly found in a separate and apparently compound form, following the noun, which was then sometimes (though not always) heard in the shortened or "construct" form. Thus with *hisēpi*, axe, we have:

hisēp' migītōwi	(or *mikītowi*) my axe	*hisēp' mahgītowi*	our axe
hisēp' yiñgītowi	thy axe	*hisēp' iñgītombūi*	your axe
hisēp' gītowi	his axe	*hisēp' gitohnēi*	their axe

So *sās*, bed, has *sās miñjītowi*, my bed, *sas yingītowi*, thy bed, *sas gītowi*, his bed.

With *tçoñgo*, dog, we find a different form:

tçoñgo wahkimpi	my dog	*tçongo maokimpi* (or *mahkimpi*)	our dog
tçoñgo yahkimpi	thy dog	*tçongo yahkimpūi*	your dog
tçoñgo eohkimpi	his dog	*tçoñgo kimpena*	their dog

The first of these forms, *migītowi*, &c., is evidently the same that appears in the Dakota *mitawa*, mine, *witawa*, thine, *tawa*, his, *uñkitawa*, ours. The Hidatsa has similar forms, *matamae*, *ditamae*, and *itamae*, often pronounced *matawae*, *nitawae*, and *itawae*. Dr. Matthews regards them as compounds formed by prefixing the pronouns *mata*, *dita* (*nita*) and *ita* to the noun *mae* (or *wae*) signifying personal property, which seems a very probable explanation.

The form *wahkimpi* may be similarly explained. In Dakota *kipá* signifies, to keep for me, and *kipi*, to hold or contain. The sense of property or possession is apparently implied, and *tçongo wahkimpi* in Tutelo probably means "the dog my property," or "the dog I have."

The possessive pronouns are used by themselves in Tutelo in the following affirmative and negative forms:

mimigītōwi (or *mimigītowe*, or *mikītowi*)	mine, or, it is mine
yiñgītowi (*yingītowe*, *yiñkītowi*)	thine, or, it is thine
iñgītowi (*iñgītowe*, *iñkītowi*)	his, or, it is his
maqgitowi (or *mahgītowe*, or *mahkitowi*)	ours, or, it is ours
yingitombūi (or *yiñkitombui*)	yours, or, it is yours
gitoñnēsel (or *kitoñnesel*)	theirs, or it is theirs

Negative Form.

kimigĭtonañ (*kimikĭtonañ*)	it is not mine
kiñyigĭtonañ	it is not thine
kigĭtonañ	it is not his
kinaqgitonañ	it is not ours
kiñyigĭtombōnañ	it is not yours
kigĭtoqnēnañ	it is not theirs

The proper form of the first personal affirmative is doubtless *migĭ'owi* (or *mikĭtowe*). In *mimigĭtowi* the first syllable is evidently from the separate pronoun *mĭm*, I, used for emphasis. In the Dakota the forms *miye mitawa*, me, mine, *niye nitawa*, thee, thine, &c., are used for the same purpose.

The negative form is not found in either the Dakota or the Hidatsa, and may be regarded as another instance of the greater wealth of inflections possessed by the Tutelo.

The following are the interrogative demonstrative and indefinite pronouns in the Tutelo, so far as they were ascertained. The Dakota and Hidatsa are added for comparison :

Tutelo.	Dakota.	Hidatsa.	
ētowā, or *hetōa*	*tuwe*	*tape*	who ?
ākeñ, *kaka*	*taku*	*tapa*	what ?
ētuk	*tukte*	*to* ; *tua*	which ?
tokē iuñ	*tonu* ; *tonaka*	*tuami*	how many ?
tewakĭtūnwā	*tuwetawa*	*tapeitamae*	whose (is it) ?
nēke, or *nēikiñ* ; *heiki*	*de*	*hidi* ; *kini*	this
yukān ; *hēwa* ; *enā*	*he* ; *ka*	*hido* ; *hino*	that
ohōn, or *ohō*	*ota*	*ahu*	many
hōk, *hūk*, *ōkahōk*	*owasiñ* ; *iyuqpa*	*etsa* ; *qakaheta*	all

The general resemblance of most of these forms is apparent. In the Tutelo for "whose ?" which might have been written *tewagĭ'ūñwa*, we see the affix of the possessive pronoun (*gĭ'owe*) inflectedto make an interrogative form. The Dakota and Hidatsa use the affix (*tawa* and *tamae*) without the inflection.

The Verb.

There are two very striking peculiarities in which the Dakota and Hidatsa dialects differ from most, if not all, Indian languages of other stocks. These are: firstly, the manner in which the personal pronoun is incorporated with the verb; and, secondly, the extreme paucity or almost total absence of inflections of mood and tense. In the first of these peculiarities the Tutelo resembles its western congeners ; in the second it differs from them in a marked degree—more widely even than the Latin verb differs from the English. These two characteristics require to be separately noted.

In most Indian languages the personal pronouns, both of the subject and of the object, are in some measure either united with the verb or in-

dicated by an inflection. The peculiarity which distinguishes the languages of the Dakotan stock is found in the variable position of these incorporated pronouns. They may be placed at the beginning, at the end, or between any two syllables of the verb. The position of the pronoun is not, however, arbitrary and dependent on the pleasure of the speaker. It appears to be fixed for each verb, according to certain rules. These rules, however, seem not yet to have been fully determined, and thus it happens that a Dakota dictionary must give the place of the pronoun in every verb, precisely as a Latin dictionary must give the perfect tense of every verb of the third conjugation. Thus, for example, in the Dakota proper, *kaçká*, to bind (or rather "he binds"), makes wa*káçka*, I bind, ya*kakça*, thou bindest; *manoñ*, he steals, makes *ma*wá*noñ*, I steal, *ma*yá*noñ*, thou stealest; and *etçiñ*, he thinks, makes *etçáñ*mi, I think, *etçáñ*ni, thou thinkest, the suffixed pronouns receiving a peculiar form. In the Hidatsa, *kidĕçi*, he loves, makes ma*kidĕçi*, I love, da*kidĕçi*, thou lovest; *eke*, he knows, becomes *e*ma*ke*, I know, and *e*da*ke*, thou knowest; and *kitsahike*, he makes good, becomes *kitsahike*ma, I make good, and *kitsahike*da, thou makest good. The Tutelo has the pronouns sometimes prefixed, and sometimes inserted; no instances have been found in which they are suffixed, but it is by no means improbable that such cases may occur, as verbs of this class are not common in either of the former languages, and our examples of conjugated verbs in Tutelo are not very numerous. Among them are the following:

1. Verbs with prefixed pronouns:

lakpése, he drinks
ya*lakpése*, thou drinkest
wa*lakpése*, I drink

hiantkapēwa, he sleeps
ya*hiantkapēwa*, thou sleepest
wa*hiantkapēwa*, I sleep

tēwa, he is dead
yi*tēwa*, thou art dead
wi*tēwa*, I am dead

2. The verbs in which the pronouns are inserted seem to be the most numerous class. The following are examples:

hahēwa, he says
*ha*yi*hēwa*, thou sayest
*ha*wa*hēwa*, I say

mahanáñka, he sits down
*maha*yi*náñka*, thou sittest down
*maha*mi*náñka*, I sit down

iñksēha, he laughs
*iñ*ya*ksēha*, thou laughest
*iñ*wa*ksēha*, I laugh

oháta, he sees
*o*ya*háta*, thou seest
*o*wa*háta*, I see

The pronouns may be thus inserted in a noun, used with a verbal sense. Thus *wahtā'ka* or *wahtakai*, man or Indian, may be conjugated:

wahtākai, he is an Indian
wayiʰhtā'kai, thou art an Indian
wamihtākai, I am an Indian

It is remarkable, however, that the pronoun of the first person plural is usually (though not always) prefixed. Thus from *mahanāñka*, he sits down, we have (as above) *mahaminañka*, I sit down, and mañk*mahanānka*, we sit down. So, mai*ñksēha* (or sometimes wai*ñksēha*), we laugh, and ma*ohata*, we see. On the other hand, we find *ha*mank*hewa*, we say, from *hahewa*, he says, making (as above) *ha*wa*hewa*, I say.

The word *manoñ*. he steals, has in Dakota the pronouns inserted, as is shown in the examples previously given. The similar word in Tutelo, *manōma* or *manūma*, has them prefixed, as yi*manōma*, thou stealest, ma*manōma*, I steal. But on one occasion this word was given in a different form, as *manundāñi*, he steals; and in this example the pronouns were inserted, the form of the first personal pronoun, and of the verb itself in that person, being at the same time varied, as *ma*yi*nundāñi*, thou stealest, *ma*mi*nundame*, I steal. In Dakota the place of the pronoun is similarly varied by a change in the form of the verb. Thus *baksá*, to cut off with a knife, makes *ba*wà*ksa*, I cut off (with the pronoun inserted), while *kaksá*, to cut off with an axe, makes wa*káksa*, I cut off (with the pronoun prefixed), and so in other like instances.

The other peculiarity of the Dakota and Hidatsa languages, which has been referred to, viz., the paucity, or rather absence, of all changes of mood and tense which can properly be called inflections, is in striking contrast with the abundance of these changes which mark the Tutelo verb. The difference is important, especially as indicating that the Tutelo is the older form of speech. It is an established law in the science of linguistics that, in any family of languages, those which are of the oldest formation, or, in other words, which approach nearest to the mother speech, are the most highly inflected. The derivative or more recent tongues are distinguished by the comparative fewness of the grammatical changes in the vocables. The difference in this respect between the Tutelo and the western branches of this stock is so great that they seem to belong to different categories or genera in the classification of languages. The Tutelo may properly be styled an inflected language, while the Dakota, the Hidatsa, and apparently all the other western dialects of the stock, must be classed among agglutinated languages, the variations of person, number, mood and tense being denoted by affixed or inserted particles.

Thus in the Hidatsa there is no difference, in the present tense, between the singular and the plural of a verb. *Kidĕçi* signifies both "he loves" and "they love;" *makidĕçi*, "I love," and "we love." In the future a distinction is made in the first and second persons. *Dakidĕcidi* signifies

"thou wilt love," of which *dakidĕcidiha* is the plural, "ye will love." In this language there is no mark of any kind, even by affixed particles, to distinguish the present tense from the past, nor even, in the third person, to distinguish the future from the other tenses. *Kidĕçi* signifies he loves, he loved, and he will love. The Dakota is a little better furnished in this way. The plural is distinguished from the singular by the addition of the particle *pi*, and in the first person by prefixing the pronoun *uñ*, they, in lieu of *wa* or *we*, I. Thus *kaçká*, he binds, becomes *kaçkápi*, they bind. *Wakaçka*, I bind, becomes uñ*kaçka*pi, we bind. No distinction is made between the present and the past tense. *Kaçká* is both he binds and he bound. The particle *kta*, which is not printed and apparently not pronounced as an affix, indicates the future. It sometimes produces a slight euphonic change in the final vowel of the verb. Thus *káçke kta*, he will bind, *kaçkápi kta*, they will bind. All other distinctions of number and tense are indicated in these two languages by adverbs, or by the general context of the sentence.

In lieu of these scant and imperfect modes of expression, the Tutelo gives us a surprising wealth of verbal forms. The distinction of singular and plural is clearly shown in all the persons, thus:

opēwa, he goes	*opehēhla*, they go
oyapēwa, thou goest	*oyapepūa*, ye go
owapēwa, I go	*maopēwa*, we go

Of tenses there are many forms. The termination in *ēwa* appears to be of an aorist, or rather of an indefinite sense. *Opēwa* (from *opa*, to go) may signify both he goes and he went. A distinctive present is indicated by the termination *ōma*; a distinctive past by *ōka*; and a future by *ta* or *ēta*. Thus from *ktē*, to kill, we have *waktēwa*, I kill him, or killed him, *wak-teōma*; I am killing him, and *waktēta*, I will kill him. So *ohāta*, he sees it, becomes *ohatiōka*; he saw it formerly, and *ohatēta*, he will see it. *Opēwa*, he goes (or went), becomes *opēta*, he will go, inflected as follows:

opēta, he will go	*opehēhla*, they will go
oyapēta, thou wilt go	*oyapētepa*, ye will go
owapēta, I will go	*maopēta*, we will go

The inflections for person and number in the distinctively present tense, ending in *oma*, are shown in the following example:

waginōma, he is sick	*waginōnhna*, they are sick
wayiñ ginoma, thou art sick	*wayiñ ginōmpo*, ye are sick
wameginōma, I am sick	*mañ gwaginōma*, we are sick

Ohāta, he sees it, is thus varied:

ohata, he sees it	*ohatēhla*, they see it
oyahata, thou seest it	*oyahatbua*, ye see it
owahata, I see it	*maohata*, we see it

ohatiōka, he saw it	*ohatiokehla*, they saw it
oyahatiōka, thou sawest it	*oyahatiokewa*, ye saw it
owahatiōka, I saw it	*maohatioka*, we saw it
ohatēta, he will see it	*ohatetēhla*, they will see it
oyahatēta, thou wilt see it	*oyahātetbūa*, ye will see it
owahatēta, I shall see it	*maohātēta*, we shall see it

The following examples will show the variations of person in the aorist tense :

hahēwa, he says	*hahēhla*, they say
hayihēwa, thou sayest	*hayihēpua*, ye say
hawahēwa, I say	*hamañkhēwa*, we say
kīhnindēwa, he is hungry	*kīhnindēse*, they are hungry
yikīhnindēwa, thou art hungry	*kīhnindēpūa*, ye are hungry
mikīhnindēwa, I hungry	*mahkihnindēwa*, we are hungry.

Wakoñspēwa, I remember it, an aorist form, becomes in the preterite *wakoñspeōka*, and, in the future, *wakoñspēta*. It is thus varied in the aorist and past tenses :

wakoñspēwa, I remember it	*makikoñspēwa*, we remember it
yakoñspēwa, thou rememberest it	*yakoñspepūa*, ye remember it
kikonspewa, he remembers it	*kikoñspēhēla*, they remember it
wakoñspeōka, I remembered it	*makikoñspeōka*, we remembered it
yakoñspeōka, thou rememberedst it	*yakoñspepuyoka*, ye remembered it
kikoñspēoka, he remembered it	*kikoñspeleōka*, they remembered it

In several instances verbs were heard only in the inflected forms. For the simple or root-form, which doubtless exists in the language, we are obliged to have recourse to the better known Dakota language. Thus *opewa*, he went, and *opeta*, he will go, indicate a root *opa*, he goes, which is actually found in the Dakota.

So *manōma* (which is probably a distinctively present tense), and *manondañi*, both meaning he steals, indicate a briefer root-form which we find in the Dakota *manoñ*, having the same meaning. *Manōma*, which is probably a contraction of *manoñōma*, is thus varied :

manōma, he steals	*manoñnese*, they steal
yimanōma, thou stealest	*yimanompūa*, ye steal
mamanōma, I steal	*mañkmanōma*, we steal

From these examples it is evident that there are variations of inflection, which, if the language were better understood, might probably be classified in distinct conjugations. Other instances of these variations will be given hereafter.

It is well known that in the Iroquois, Algonquin, Cherokee, and other Indian languages, of different stocks, there are many forms of the verb, nega-

tive, interrogative, desiderative, and the like, which are among the most notable characteristics of these languages, and add much to their power of expression. The Tutelo has several of these forms, but none of them are found in the Dakota or Hidatsa, both of which express the meaning of these forms by adverbial phrases or other circumlocutions. The negative form in Tutelo is made (in a manner which reminds us of the French *ne-pas*) by prefixing *k* or *ki* to the affirmative and suffixing *na*. The tense terminations *oma*, *owa*, and *ewa*, become *ona* and *ena* in this form :

inksēha, he laughs	*kinksēhna*, he does not laugh
iñwaksēha, I laugh	*kiñwahsehna*, I do not laugh
wameginōma, I am sick	*kiwameginōna*, I am not sick
waktēwa, I killed him	*kiwaktēna*, I did not kill him
owaklāka, I speak	*kowaklākna*, I do not speak
wakteōma, I am killing him	*kiwakteōna*, I am not killing him
yahōwa, he is coming	*kiahōna*, he is not coming

Kiñksēhna, he is not laughing, is thus varied in the present tense :

kiñksēhna, he is not laughing!	*kiñksehanēna*, they are not laughing
kiñyaksēhna, thou art not laughing	*kiñyaksēhpuna*, ye are not laughing
kiñwaksēhna, I am not laughing	*kimaeñksēhna*, we are not laughing

The interrogative form terminates in *o*, as :

yaktēwa, thou killedst him	*yaktēwo*, didst thou kill him ?
yakteoma, thou art killing him	*yakteoñmo*, art thou kiling him ?
yatēta, thou wilt kill him	*yaktēto*, wilt thou kill him ?
yatīwa, thou dwellest	*toka yatiwo*, where dost thou dwell ?
alēwa, he is going	*toka alewo*, where is he going ?

It is evident that this form is an inflection, pure and simple. It is a vowel change, and not in any manner an agglutinated particle. It takes the place of that elevation of tone with which we conclude an interrogative sentence, and which, strange to say, is not heard among the Dakotas. Mr. Riggs remarks that "unlike the English, the voice falls at the close of all interrogative sentences."

The desiderative form appears to be expressed by the affixed particle *bi* or *be*, but the examples which were obtained happened to be all in the negative, thus :

owapēwa, I go	*kowapēbina*, I do not wish to go
opetēse, he is going, or will go	*kopēbenise*, he does not wish to go
hawilewa, I come	*kiwilēbina*, I do not wish to come
waktewa, I kill him	*kiwaktēbina*, I do not wish to kill him

The imperative mood is distinguished apparently by a sharp accent on the final syllable of the verb, which loses the sign of tense. Thus from the *ñgō*, to give (in Dakota and Hidatsa, *ku*), which appears in *maingōwa*, I

give to you, we have, in the imperative, *masā mingó*, give me a knife. *kitēse* or *kitesel*, he kills him, gives *kitē tçoñki*, or *tçoñk' kitē*, kill the dog.

In the western languages of the Dakota stock, certain particles prefixed to the verb play an important part in modifying the meaning. Thus in Dakota and Hidatsa the prefix *pa* signifies that the action is done with the hand. From *ksa*, Dak., meaning separate, we have *paksá*, to break with the hand; from *qu*, Hid., to spill, *paqu*, to pour out with the hand. The Dakota *na*, Hidatsa *ada* (for *ana*) are prefixes showing that the action is done with the foot. The Dakota *ya*, Hidatsa *da* (often pronounced *ra* or *la*) show that the act is done with the mouth. *Ka* (Dak.) and *dăk* (Hid.) indicate an act done by a sudden, forcible impulse, &c. Attempts were made to ascertain whether similar prefixes were employed in the Tutelo speech. It was found that in many cases the latter had distinct words to express acts which in the western languages were indicated by these compound forms. Still, a sufficient number of examples were obtained to show that the use of modifying prefixes was not unknown to the language. Thus the root *kusa*, which evidently corresponds with the Dakota *ksa*, signifying separation, occurs in the following forms:

nantkūsisel, he breaks it off with the foot
latkūsisel, he bites it off
tikūsisel, he breaks it off by pushing
lakatkūsisel, he cuts it off with an axe

The Dakota *na*, signifying action with the foot, is evidently found, with some modification, in the Tutelo *nantkūsisel* above quoted, and also in *nañkōkisek*, to stamp with the foot, and in *konaqlōtisel*, to scratch with the foot. So the cutting, pushing, or impulsive prefix, *lak* or *laka*, which appears in *lakatkūsisel*, is found also in *lakatkūsisel*, he cuts open, *lakaspēta*, to cut off in pieces, *lakasāse*, to chop, *lakapleh*, to sweep the floor. *La*, which in *latkūsisel* indicates action with the mouth, is found also in *lakpēse*, to drink, and perhaps in *yilanāha*, to count or read, which has the corresponding prefix *ya* in the Dakota word *yăwa*, of like meaning

The affixed or incorporated pronouns are used with transitive verbs to form what are called by the Spanish writers on Indian grammar *transitions*, that is, to express the passage of the action from the agent or subject to the object. This usage is governed by very simple rules. In the Dakota and Hidatsa the rule prevails, that when two affixed pronouns come together, the one being in the nominative case and the other in the objective, the objective always precedes the nominative, as in *mayakoçka* (Dak.) me-thou-bindest, *dimakidēci* (Hid.) thee-I-love. In the Dakota the third personal pronoun is in general not expressed; *kaçká* signifies both he binds, and he binds him, her, or it; *wakáçka* is I bind, and I bind him, &c. In the Hidatsa, this pronoun is not expressed in the nominative, but in the objective it is indicated by the pronoun *i* prefixed to the verb, as *kidēçi*, he loves; *ikideçi*, he loves him, her or it.

The Tutelo, as far as could be ascertained, follows the usage of the Dakota

in regard to the third personal pronoun (which is not expressed) but differs from both the other languages, at least in some instances, in the order of the pronouns. The nominative affix occasionally precedes the objective, as in MAYI*newa*, I-thee-see. Yet in *kohinañ*'kWIYA*hewa*, me-thou-struckest (where the pronouns are inserted), this order is reversed. The rule on which these variations depend was not ascertained. Owing to the difficulties of an inquiry carried on through the medium of a double translation (from English into Cayuga or Onondaga, and from the latter into Tutelo), it was not easy to gain a clear idea of the precise meaning of many of the examples which were obtained. An Indian when asked to translate "I love thee," or "thou lovest me," unless he is an educated man, or perfectly familiar with the language in which he is addressed, is apt to become perplexed, and to reverse the meaning of the pronouns. The following examples, however, will suffice to show that the system of transitions exists in the Tutelo, though they do not enable us to analyze and reconstruct it completely. Many other examples were obtained, but are omitted from a doubt of their correctness.

wakteōma, I am killing him
waikteōma (for *wayikteōma*) I am killing thee
mikteōma he is killing me
yakteōma, thou art killing him
kiteōñsel, he is killing them

inēwa, he sees him (or he saw him)
minēwa, I see him (qu. *m'inēwa*, for *ma-inēwa*)
mayinēwa, I see thee
miinēwa, he sees me
yiinēwa, he sees thee
miinēhla, they see me

yandostēka, he loves him
yandomistēka, he loves me
yandoyistēka, he loves thee
yandowastēka, I love him
yandoyastēka, thou lovest him
yandoyistēka, he loves thee
mankiandostēka (qu. *maikiandoyistēka*), we love thee
maihiandostekanēse, we love them
waiyandostēka, he loves us
waiyandoyastēka, thou loved us
yandostekanēse, he loves them (or they love him)
yandomistēkana, they love me

kohinañhīwa, he struck (or strikes) him
kohinañkyihīwa, he struck thee
kohinañmihīwa, he struck me

kohinañwahīwa, I struck him
kohinañyahīwa, thou struckest him
kohinañkwiyahīwa, thou struckest me
kohinañmañkihīwa, we struck him

gikōha (or *kikōha*), he calls to him
wigikōha, I call to him
waingikōha, (for *wayingikōha*), I call to thee
iñjikohīse (for *yingikohīse*), he calls to thee
iñjikopolēse, he calls to you
miñjikoha, he calls to me
yigikoha, thou callest to him
ingikopūa, they call to you
gikohanēse, they call to them

From the foregoing examples it is evident that the system of transitions in the Tutelo is as complete as in the Dakota and Hidatsa. But there are apparently some peculiar euphonic changes, and some of the pronouns are indicated by terminal inflections, particularly in the second person plural and in the third person singular and plural.

In the Tutelo, as in the Dakota and Hidatsa, substantives and adjectives are readily converted into neuter verbs by the addition or insertion of the pronouns and the verbal suffixes. It is in this manner that these languages, like other Indian tongues, are generally enabled to dispense with the use of the substantive verb. Thus in the Dakota *witçaçta*, man, by inserting the pronoun *ma*, I, becomes *wimatçaçta* or *witçamaçta*, I am a man, and by inserting *uñ* (we) and adding the plural affix *pi*, becomes *wiuñ'çaçtapi*, we are men. So also *waçte*, good, becomes *mawaçte*, I am good, *uñwaçtepi*, we are good.

In the Tutelo the word *wahtāka*, or *wahtākai*, man, is inflected as follows:

wamihtākai. I am a man.
wayihtākai, thou art a man.
wahtākai, he is a man.
miwamihtākai, we are men.
iñwahtākai, ye are men.
hūkwahtākai, they are men.

The last two forms appear not to be regular, and may have been given by mistake. *Hūkwahtākai* probably means "all are men."

This verb may take the aorist form, as:

wamihtakāwa, I am (or was) a man.
wayihtakāwa, thou art (or wast) a man.
wahtakāwa, he is (or was) a man, &c.

So the adjective *bī*, good, becomes, with the aorist affix *wa*, *bīwa*, he is (or was) good; *yimbīwa*, thou art good; *mimbīwa*, I am good. In the

present tense we have *ebīse*, he is good; *ebilēse*, they are good; and in the preterit, *ebikōa*, he was good.

Adverbs.

In many cases, as has been already shown, the English adverb is indicated in the Tutelo by a modification of the verb. The negative adverb, for example, is usually expressed in this manner, as in *iñkseha*, he is laughing, *kiñksehna*, he is not laughing; *migītowe*, it is mine, *kimigītonañ*, it is not mine.

Sometimes the meaning which in English would be expressed by an adverb accompanying a verb, is expressed in Tutelo by two verbs. Thus we have *ihōha*, she is sewing, apparently from a root *ihō* or *yehō*, to sew; and *koñspēwa yehō*, she is sewing well, *i. e.*, she is careful in sewing (lit., she thinks, or remembers, in sewing); *kebīna yehō*, she is sewing badly, *i. e.* she does not well in sewing (or is not good at sewing). Here *kebīna* is the negative form of *biwa*, he (or she) is good.

Prepositions.

Many phrases were obtained with a view of ascertaining the prepositions of the Tutelo, but without success. Sometimes an expression which in English requires a preposition would in the Tutelo appear as a distinct word. Thus, while *ati* signifies a house, *tokai* was given as equivalent to "in the house." It may perhaps simply mean "at home." Prairie is *latāhkoi*, but *onīi* signifies "at the prairie."

Other examples would seem to show that the prepositions in the Tutelo, as in the Hidatsa, and to a large extent in the Dakota, are incorporated with the verb. Thus *tāhkai* signifies "woods," and *tāhkai aginēse*, he is in the woods. So *sūi*, hill, and *sūi aginēse*, he is on the hill. The phrase "I am going to the house" was rendered *wilēta iatī*, and the phrase "I am coming from the house," by *waklēta iatī*. The practice of combining the preposition with the verb is very common in the Indian languages, which merely carry to a greater extent a familiar usage of the Aryan speech. The expressions, to ascend or descend a hill, to circumnavigate a lake, to overhang a fence, to undermine a wall, are examples of an idiom so prevalent in the Indian tongues as to supersede not merely the cases of nouns, but to a large extent the separable prepositions.

Conjunctions.

In the Tutelo, conjunctions appear to be less frequently used than in English. An elliptical form of speech is employed, but with no loss of clearness. The phrase "when I came, he was asleep," is expressed briefly *wihīok, hiañka*, I came, he was asleep. So, "I called the dog, but he did not come," becomes *wagelākiok tçoñk, kihūna*, I called the dog, he came not. When it is considered necessary or proper, however, the conjunction is expressed, as *kuminēna, mi Jān hinēka*, I did not see him, but John saw him. Here "but" is expressed by *mi*.

Nigás signifies "and," or "also." *Waklumīha lubūs nigás masīñ*, I bought a hat and a knife. *Owakiōka waktāka nigás mihīñ nomba lek*, I met a man and two women.

Li, which expresses "if," appears to be combined with the verb, at least in pronunciation; thus: *Lihīok, wagelāgita*, If he comes, I will tell him; *wihūta, Jan lihiōk*, I will come if John comes. It is noticeable in the last two examples that the accent or stress of voice in the word *lihiok*, if he comes, appears to vary with the position of the word in the sentence.

Syntax.

The only points of interest which were ascertained in regard to the syntax of the language related to the position of words in a sentence.

The adjective follows the noun which it qualifies, as *wahtake bī*, good man, *atī asāñ*, white house. The rule applies to the numerals, as *miháñ noñsa*, one woman, *atī noñbai*, two houses. In this respect the Tutelo conforms to the rule which prevails in the Dakota and Hidatsa languages, as well as in the dialects of the Iroquois stock. In the Algonkin languages, on the other hand, the adjective precedes the noun.

The position of the verb appears to be a matter of indifference. It sometimes precedes the noun expressing either the subject or the object, and sometimes follows it, the meaning being determined apparently, as in Latin, by the inflection. Thus "I see a man," is *minēwa waiwāq* (I see him a man); and "the man sees me" is *miinēwa waiwāq* (he sees me the man). *Tçoñko miñgō*, give me a dog; *kitē tçoñki*, kill the dog. In the last example the change from *tçoñko* to *tçoñki* is apparently not a grammatical inflection, but is merely euphonic. The verb in the imperative mood sufficiently shows the speaker's meaning, and the position of the noun is a matter of emphasis. "A *dog* give me," not a knife; "*kill* the dog," don't let him escape.

A verb is placed after another verb to which it bears the relation expressed by our infinitive; as *miñgiloqkō waktēta*, let me kill him (allow me, I will kill him). *Wakonta opēta*, I will make him go (I cause him he will go).

The euphonic changes which words undergo in construction with other words are as marked in this language as they are in the proper Dakota tongue, and seem to be often of a similar, if not identical, character in the two languages. Thus in Dakota the word *çuñka*, dog, becomes *çuñke* when a possessive pronoun is prefixed. In the Tutelo a similar change takes place when the position of the noun is altered; thus we have *tçoñko miñgō*, give me a dog; *kitē tçoñki*, kill the dog. The terminal vowel is frequently dropped, and the consonant preceding it undergoes a change; thus in Dakota *yuza*, to hold, becomes *yus* in the phrase *yus mạjin*, to stand holding. In Tutelo *nahāmbi* (properly *nahāñbi*) or *nahābi*, day, becomes *nahāmp* (or *nahāp*), in *nahāmp lāli* (or *nahāp lali*), three days. In such instances the two words which are thus in construction are pronounced as though they formed a single word.

VOCABULARY.

Particular care was taken to obtain, as correctly as possible, all the words comprised in the comparative vocabulary adopted by Gallatin for his Synopsis of the Indian languages. Many other words, expressive of the most common objects or actions, have been added. The alphabetical arrangement is adopted for convenience of reference, in lieu of the different order which Gallatin preferred for the purposes of his work. The Dakota and Hidatsa words are derived from the dictionaries of Mr. Riggs and Dr. Matthews, with the necessary changes of orthography which are required for the direct comparison of the three languages.

When several words are given in the Tutelo list, they are sometimes, as will be seen, mere variations of pronunciation or of grammatical form, and sometimes entirely distinct expressions. The Tutelo has no less than four words for "man," *wahtāka, waiyūwa* (or *waiwaq*) *yū'ɩkañ*, and *nōna*, which have doubtless different shades of meaning, though these were not ascertained. There are also two distinct words meaning "to see," *inēwa*, and *ohāta*, and two for "go," *opēwa* and *qala* (or, rather *opa* and *la*, answering to *opa* and *ya* in Dakota). A more complete knowledge of the language would doubtless afford the means of discriminating between these apparently synonymous terms.

The words marked N in the vocabulary are those which were received from Nikonha himself. The pronunciation of these words may be accepted as that of a Tutelo of the full blood, and as affording a test of the correctness of the others.

	Tutelo.	Dakota.	Hidatsa.
Alive	inī, enī, inīna	ni	hiwakatsa
All	hūk, hōk, okahōk	iyuqpa	qukaheta ; etsa
And	nigás	kha : tçɩ ; uñkañ ; nakuñ	iça
Arm	hiç:o (N) histo	isto	ara
Arrow	mañksīi; māñkōi (N)	wañhiñkpe	ita, maita
Ashes	alapōk	tçɩqota	midūtsapi
Aunt	watemai ; tomīn	tuñwin	içami ; ika
Autumn	tāñyi, tā'i	ptañyetu	mata
Awake	kiklēse	kikta	itsi ; hidamitats
Axe	nisēp (N), hisēpi, hiɛép	oñspe	maiptsa
Bad	okāyek (N) okāyik, ukāyik	çitçɩ	icia
Bag	mañksūi	ojuha	içi
Ball	tapi	tapa	máotàpi
Berk (*n*)	qāpi ; yohiñk	çañha	midaiçi ; qùpi (v)
Bear	mūnti (N) mōnti, mondi	mato	daqpitsi
Beads	watai	totodañ	akutohi

	Tutelo.	Dakota.	Hidatsa.
Beaver	yāop (N) munaqka	tçıpa	mirapa
Beard	yēhī ; istihiōi	putiñhiñ (hiñ, hair, içti, underlip)	iki (hi, hair)
Bed	sāsi	owinja	aduqùpi
Beg	oyándise	da ; kida	kadi
Bird	māyīñk	zitká ; wakiñyañ	tsakaka
Bird's nest	mayeñgiéqta,	hoqpi	ikiçi
Bite off (to)	latkūsisel,	yaksá	adudatsa
Black	asépi, asùp (N)	sapa	cipi
Blood	wāyī (N)	we	idi
Blue	asōti	to ; sota	tohi
Body	tēsi ; yūqtéki	tañçañ ; (tezi, belly)	iqo (titsi, thick, stout)
Boil (to)	hīehā	ohañ ; ipiqya	midue
Bone	wahōi, wahūi	hu	hidu
Book	minagi	wowapi	
Boy	wakasīk (N); guts-kai ; waitiwa	hokçidañ ; koçká	makadistamatse
Bow (n)	inōsīk, inōsek (N)	itazipa ; tinazipe	itanuqa ; minuqa
Brain	wasōti, wasūt	nasu	tsuùta
Bread	wagesākwāi, wāk-sākpāi	aguyapi	madahapi
Break (to) with foot	lakatkūsisel	naksá	anaqoqi
Brother	niwāgenúmpai (N) iñginumbai	tciñye	iaka; itanu; itame-tsa
Brother, elder (my)	witañsk ; wital ; wa-hīik	tciñye ; timdo	itametsa ; iaka
Brother, younger (my)	wisuñtk, minōn	misuñka	matsuka
Buffalo	iap; mampañdahkai	tatañka ; pte	kedapi ; mite
Burn (v. a.)	inausíngā	ghu ; aghu	anaqa
Bury	sùntése	ga ; huaka	
But	mi	tuka	
Buy	kilomīha ; wāglu-mihínta	opetoñ	maihu
Call (v. a.)	kikōha ; gelāki	kitço	kikuha (invite)
Canoe	miñkolhāpi, meñ-kolahāpi	wata ; cañwata	midaluetsa; mina-luetsa
Cat	pūs (N) (i. e. puss)	inmuçuñka (dog-panther)	
Cause (v)	konta	etçonkiya	

	Tutelo.	Dakota.	Hidatsa.
Cheek	ùkstéh	tapoñ, iyoqa	
Cherry	yosañkrota	tcañpa, kakañpidan	matsu
Child	wakasīk; wāgots-kāi (see *small*)	hokçiyopa	daka; makadiçta
Chop (*v*)	lakasāse	kaksa	naktsùki
Churn (*v*)	mampamasawohōka	botço	
Claw	oluskēse	tsake	tsakaka itsi
Cloud	maqōsi (N)	maqpiya	
Club	yehēti	tçañ otoza	midakaza titsi
Cold	sanī	sni	tsinīe
Come	yahūa, howa, hī	uwa	hu
Copper	penihēi	maza	netsahiçiçi
Count (*v*)	yilanāha	yawa	
Cranberry	hohnùñk	potkañka, potpañka	
Crane	kainstākai	pehañ	opitsa
Crow (*n*)	kāhi	untçiçitçadañ	pedetska
Cry (*v*)	qāqise	tçeya	imia
Cut (*v*) *with knife*	lakatkōsa	bakså	naktsùki
Dance (*v*)	wagitçi (N), ketçi	watçi	kidiçi
Darkness	usīhaa, ohsīha	okpaza (hañ, *night*)	oktsi; tatsi
Daughter (*my*)	witēka (N), wi-ohañke, miohañk	mitcuñkçi	maka
Day	nahambe, nahamp, nahañpe	añpetu, añpé	mape
Dead	tē, tēka	ta	te
Deer	witāi	taqiñtça	tçitatùki
Devil (*evil spirit*)	māmpā isī	wakañçitça	
Die	tē (N), tēolāha	ta	te
Dog	tçoñg (N) tçoñgo tçoñki, tçoñk	çunka	maçuka
Drink (*v*)	lākpē, lapēta	yatkañ	hi; minhi
Duck	īçtai (N), heistañ, manēasēi (see *Goose*)	maghaksitça; skiska	miqaka
Ear	naqōq (N), nahūh	noghe; nakpa	akuqi
Earth	amāni, amāi	maka	ama
Eat	lūti	yuta	duti (nuti)
Egg	mayiñk pōs (see *Bird*)	witka	tsakakadaki
Eight	pālán (N) palāni, palāli	çadoghan	nopapi

	Tutelo.	Dakota.	Hidatsa.
Eighteen	agepalāli, akipalāni	ake çadoghañ	aqpidopapi
Eleven	agenosai, akinosai	ake wanjidañ	aqpiduetsa
Evening	osihitewa (see *Darkness, Night*)	qayetu	oktsiade
Eye	tasūi, tasūye (N) (mentasūi, my e.)	içta	içta
Face	talūkna ; tarūbna (mentalōken, my f.)	ite ; itohnake	ite
Father	eāti; tāt (N); yāt (N)	ate	ate ; tatiç
Fifteen	agegīsai, akekisāi	ake-zaptañ)	aqpikiqu
Finger	hāk (see *Hand*)	nape	çakiadutsamihe
Finger-nails	tsutsāki, tçutçāg	çake	çakiiçpu
Fire	pītç (N) pēti, pētç	peta	
Fish	wihoi (N)	hoghañ	mua
Five	kasā (N) kisē, kisañ, kisāhi, kisāháñi	zaptañ	kiqu
Flesh	wāyuqtéki, wayūqtik	tçeqpi ; tçonitça	idukçiti
Fog	manotihūa	opo	pue
Food	walūti	woyute	maduti
Foot	içi (N) isī	siha	itsi
Forehead	tikōi ; pania minte	ite	iqi
Forest	tāhkāi	tçoñtañka	
Four	tōp (N), tōpa, topai, toba	topa	topa
Fourteen	agetoba, akitopa	ake-topa	aqpitopa
Fox	tohkai	çuñgidañ	iqoka
Friend	witāhe, witaqā	koda ; kitçuwa	idakoe ; iko'pa
Ghost	wanùntçī	wanaghi	nokidaqi
Girl	wāgatç(N) wakasīk; kōmqāñ (N)	witçiñyañna	makadiçtamia ; miakaza
Go	opewa ; qala ; la	ya ; opa	nakon ; ne ; kaua
God	ēiñgyeñ, eīñgă	wakañtañku	daqi, naqi (spirit)
Good	ebī (N), bi, pī, ipī, bīwa	waçte ; pi (obsolete)	tsūki
Goose	manēasān	magha	mina
Grandfather	ekuñi, higūñ	tuñkañçidañ	adutaka
Grandmother	higūñ	kuñsitku ; uñtçi	iku
Grass	sùnktāki (N), muktāgi ; otōi	peji	mika'
Great	itáñi (N), itāñ	tañka	iqtia
Green	otō (N), otolakōi	to	tohiça

	Tutelo.	Dakota.	Hidatsa.
Gun	mīnktē (N)	mazakañ	
Hail	nōq	wasu	ma'kùqpitami
Hair	natónwe(N), nañtói, natói	natú; hiñ	ana; hi
Hand	hāg (N), hāki, āk	nape (çake, claw, finger-nail)	çaki
Handsome	pirē (N), ipī, ipīkam (see *good*)	owañyag waste	
Have	tahoñtanēki	tiñ-maçtiñtça	itūki
Hat	lubūs; kotubóa (N)	wapaha	apoka
Hatchet	(see *axe*)		
He	im, i	iç, iye	i, çe
Head	pasūye (N), pasūi	pa	atu
Heart	yāñti (N), yanti; tāpī	tcante (tapi, liver)	na'ta (apiça, liver)
Here	nei	den, detu	
Him	e, ei, i	iye, iç	i
Himself	esái, isáñi	iye, iç	iqki
House	atī (N)	tipi	ati
How many	tokēnuñ	tona, tonaka	tuami, tuaka
Hundred	ukenī, okeni	opawiñghe	pitikiqtia
Hunger (v)	kihnindewa	wotektehda (hungry)	aniiti (hungry)
Husband	māñki	hihna	kida, kina
I	ma, mi, mīm	miç, miye	ma, mi
I alone or I myself	misáñi, misāi	mīye, miç, miçnana	miqki, mitsaki
Ice	noñhi; mīñgiratçah	tçagha	manūqi
If	li	kiñhañ	
Indian	wahtākai (*man*)	iktçewitçasta	amakanoqpaka
Iron	mañs, mās, masīqorāk	mazasapa	uetsa
Island	histēk, stēk, stestēki	wita	
Kettle	yesiñk	tçegha	miduqa
Kill	kitē (N), ktē, kitēse	kte, kata	ta, kitahe
Knife	maséñi, masēi, masāi (N) masā	isan	maetsi
Lake	(see *Sea*)		
Land	(see *Earth*)		
Laugh	inksēha, īñkçē (N)	iqa	ka'
Leaf	otōi, otōq (N)	ape; wapa	midapa

	Tutelo	Dakota.	Hidatsa.
Leg	yeksā (N), ieksā, yeksāi; minī (*my leg*)	idiki or iniki	
Long	yapóske (N) sui; yumpañkatska	hañska	hatski; (tsua, *narrow*)
Love	yandowasteka	waçtedaka	kidĕçi
Maize	mandaqēi, mātāqĕ (N)	wamnaheza	kohati
Make	aōma, aōñ	uñ	he, hini
Man	wahtahka, wāiyuā (N), waiyūwa, waiwaq; yuhkañ, nōna	witçaçta	matse, itaka, çi-kaka
Marry	ohōn, ohōteha	ota	ahu
Me	mi, wi	ma, mi	mi
Meet	oaki	akipa	uzia
Mine	migītowe	mitawa	matawae
Moon	mīnōsā' (N), mi-mahēi (see *Sun*)	hañyetu-wi	makumidi
Morning	kanabāmpuai, kana-hābnen (see *Day*)	hañhañna	ata
Mother	īnā (N). henā, henùñ	ina	hidu
Mountain	çūqe, sūhi; ohēki	qe; paha	amaqami
Mouth	ihī, īh (N)	i	i
Myself	(see "*I alone*")		
Near	iñktēi, āskai	kiyedañ	atsa
Neck	tasēi, mintasēi (my n.)	tahu ; dote	ampa
Night	usī, osī	hañ ; hañyetu	oktsi
Nine	tsāen or tça (N), sā, sāñ, ksānk ; ksā-kai, kasāñkai	naptçinwañka	nuetsapi
Nineteen	agekisañka	uñma-naptçinwañka	agpi-nuetsapi
No	yahan, ihao	hiya	desa ; nesa
None	pāqtē, paqti	poghe	apa
Oak	tāskahōi, taskahūi (N)		midakamiqka
Old	hōakāi, hōhka	kañ	qe, qie
One	noñç (N), noñs, nosāi, noñsa	wañji, sañni	nuetsa

	Tutelo.	Dakota.	Hidatsa.
Ours	maqgītowe	uñkitawa	matawae
Ourselves	maesāi, maesáñi		midohi
Partridge	wustetkai	zitça	
Pigeon	mayūtkāi, wayōtkāi	wakiyedañ	
Pine-tree	wāstī, wāste (N)	wazi	matsi
Pipe	yehíñstik (N), ihīrtik, iheñstek (qu, "*mouth-stone*")	tçotañka; tçañduhupa	ikipi
Pound (*v*)	pahē	apa	pa
Prairie	latahkoi	tiñta	amaadatsa, teduti
Rain	qawōi (N), qawōqa, häwōhā, qawō	maghaju	qade
Raspberry	hasisiāi	takañhetça	
Red	atsūti, atçūti, atçūt	duta (*scarlet*), ça (*red*)	hiçi
Remember	koñspēwa	kiksuya	
River	taksīta, taksītai	wakpa; watpa	azi
Run (*v*)	hinda, hantá (N)	inyañka	tinie
Say (*v*)	hahēwa (see *Speak*)	eya	idé
Sea	yetañi, yetāi, iētañ	mde (*lake*); miniwañtça (*one water*)	miniiqtia (*great water*)
See (*v*)	ohāta, inēwa, waqēta	toñwañ; wañyaka; wañhdaka	ika; atsiça
Seven	sāgóm (N), sagomēi, sagomíñk	çakowiñ	çapua
Seventeen	agesagōmi	ake-çakowiñ	aqpiçapua
Sew (*v*)	ihōha	kagheghe; ipasisa	kikaki
Shoes	handisonōi (N), añgohlēi, āgōre, āgōdē	tcañhañpa	hupa; itapa
Shoot off (*v*)	opatañsel	bopōta	
Sick	waginōma	yazañ	iqoade
Sing (*v*)	yāmùñiyē (N)	dowañ; ahiyaya	
Sister	minēk (N), tahañk	tawinoqtin; tañka, tanku	inu, itaku, içamí
Sit	mahanañka	iyotañka	amaki
Six	agùs (N), akásp, akāspei	çakpe	akama
Sixteen	agegaspe	akeçakpe	aqpiakama
Sky	mañtōi, matoñi, matōi	maqpiya to	apaqi

	Tutelo.	Dakota.	Hidatsa.
Sleep (*v*)	hīyăñ (N); hianta, hiantkapewa	içtiñma	hami, hinami
Small	kutçkai (N), kūtskai, kotskai	tçistiñna ; tçikadañ ; niçkodañ	kariçta
Snake	wāgenī	wañ; wamduçka	mapokça
Son	witēka (N), tēkai; qūtçkai (see *Small*)	tçinktçi (koçká, *young man*)	idiçi
Speak	níça (N), sahéñta, sabīta, hahēwa, oaklaka	ia; yaotañiñ	idé, iné
Spring (*n*)	wehahempēi, weha-éhimpē; maste	wetu (maçté, *warm*)	
Squirrel	nistāqkai	taçnahetça; hetk-adañ; ziça	
Stamp (*v*) *with foot*	nañkōkisek	natata, natañtañ	
Star	tabunītçkai (N), tap-niñskai	witçañqpi	içka
Stay (*v*)	nañka (see *Sit*)	yañka	daka
Steal	manoñ, manōma	manoñ	açadi
Stone	histéki, nistēk (N)	iñyañ	mi'
Strawberry	haspahínuk	wajuçtetça	amuáqoka
Strike	kohinùnhiwa	apa, kaçtaka	
Strong	itāi; soti; wāyupāki	suta; waç'aka	itsii
Summer	wēhē piwa (see *Spring*)	mdoketu	ade, mande
Sun	mie or mīn (N), mi (see *Moon*)	wi	midi
Sweep (*v*)	lakaplék	kahiñta	
Ten	pōtsk (N), putsk, butçk, putskai, putskáñi	wiktçemna	pitika
That	yukān; nēikiñ	ka, koñ	ku
Thee	hi, yi	ni	ni
Their	gitonnēsel	tawapi	itamae
There	kowai	hetçi; heñ; ka; kañki	hidikoa; kuadi; çekoa
They	imahese	iyepi	i
Thine	yiñgītowe	nitawa	nitawae
Thirteen	agelali	ake-yamni	aqpinami
Thirty	putçka nani	wiktçemna yamni	damia-pitika

	Tutelo.	Dakota.	Hidatsa.
This	néke, nēikiñ	de ; detçədañ	hidi ; hini
Think	opemīha ; koñspēwa	eçiñ ; epça	idie ; inie
Thou	yīm, ya, ye	niç, ya, ye	na, ni
Thousand	okeni butskai, ukenī mbutskai	kektopawiñghe	pitikiqtia akakodi
Three	nān (N) nāni, lāt, lāni	yamni	nami, nawi
Thunder	tūi ; tūhangrūa	otiñ	tahu
Thyself	yisái, yesáñi	niye, niç	niqki
Tie (*v*)	olohī	iyakaçka ; paqta	dutskiti
Tobacco	yéhni, yihnū	tçañdi	ope
To-day	nahámbleḱéñ (see *Day*)	etçin ; nakaha ; añpetu kiñ de	hini-mape
Toes	atkasusai	siyukaja ; sipiñkpa	itsiadutsamihe
To-morrow	nahampk (see *To-day*)	heyaketciñkañ	ataduk, ataruk
Tongue	netçi, netsi, letci	tçeji	dezi (nezi)
Tooth	ihī (N)	hi	i, hi
Town	māmpī, māmbī	otoñwe	ati, ati ahu
Tree	onī ; wiéñ (N) miéñ (see *Wood*)	tçañ	mina (wood)
Turkey	māndāhkāi, māndùhkāi	zitça tañka	
Twelve	agenomba	ake-noñpa	aqpidopa (agpinopa)
Twenty	putska nomba	wiktcemna noñpa	nopapitika
Two	nomp (N) nomba	noñpa	nopa, dopa
Ugly	ukāyik (see *Bad*)	owañyaq sitça	icia
Uncle (*my*)	minēk'	midekçi; ate (*father*)	ate ; itadu
Us	mae, wae	uñ	mido, wiro
Valley	oñqyāyùñ	kaksiza ; tçokañ	amaqaktupi
Walk (*v*)	yalēwa (see *Go*)	mani	dide
Warm	akāteka, akātia	kata ; tçoza ; maçte	ade
Warrior	ērutāoñe	akitçita ; mdetahuñka	akimakikua
Water	manī (N)	mini	mini, midi
We	mīm, mae, wae, mañ, māesáñ	uñ	
Weave	añktāka	yañka ; kazoñta	
Weep	qaka	tçeya	imia
Which	ētuk	tukte	tapa
What is that?	kakāñwā	taku (*what*)	tapa

	Tutelo.	Dakota.	Hidatsa.
When	tokēnāq	tohiñni ; kehañ	tuakaduk ; tuakaçedu
Where	tokā	toki, tokiya	torn, toka
White	asùñi (N), asañi, asai, asei	sañ ; ska	atùki ; oqati
Who	ketoa, hetōa	tuwe	tape
Whose	tewakī:ùnwa	tuwetawa	tapeitamae
Wife	(same as *Woman*) mihañi	tawitçu	itadamia ; ua
Wind	maniñkiē (N), mamùnklēi, maminkrē, omaklēwa	tate	hutsi
Winter	wāneñi, wānēi	wani, waniyetu	mana ; tsinic (*cold*)
Wolf	mùñktagín (N), mùnktōkāi, maktukai	çuñktoketça	motsa ; tçeça
Woman	miháñi, mihañ (N), mahēi	winohintçā, wiñyañ	mia
Wood	miyeñi, miéñ, miyēi	tçañ	mìna
Work (*v*)	oknahō	qtani	dahe ; kikça
Ye	yim (see *Thou*)	niyepi	dido ; niro
Yellow	sīi	zi	tsi
Yes	ahá, aháñ, awāqa	hañ ; ho	e
Yesterday	sitō	qtanihañ	hudiçedu ; huriçcru
Young	yéñki	askatudañ wota	
Your (*pl*)	yiñgītambūi	nitawapi	

Stated Meeting, April 20, 1883.

Present, 12 members.

President, Mr. Fraley, in the Chair.

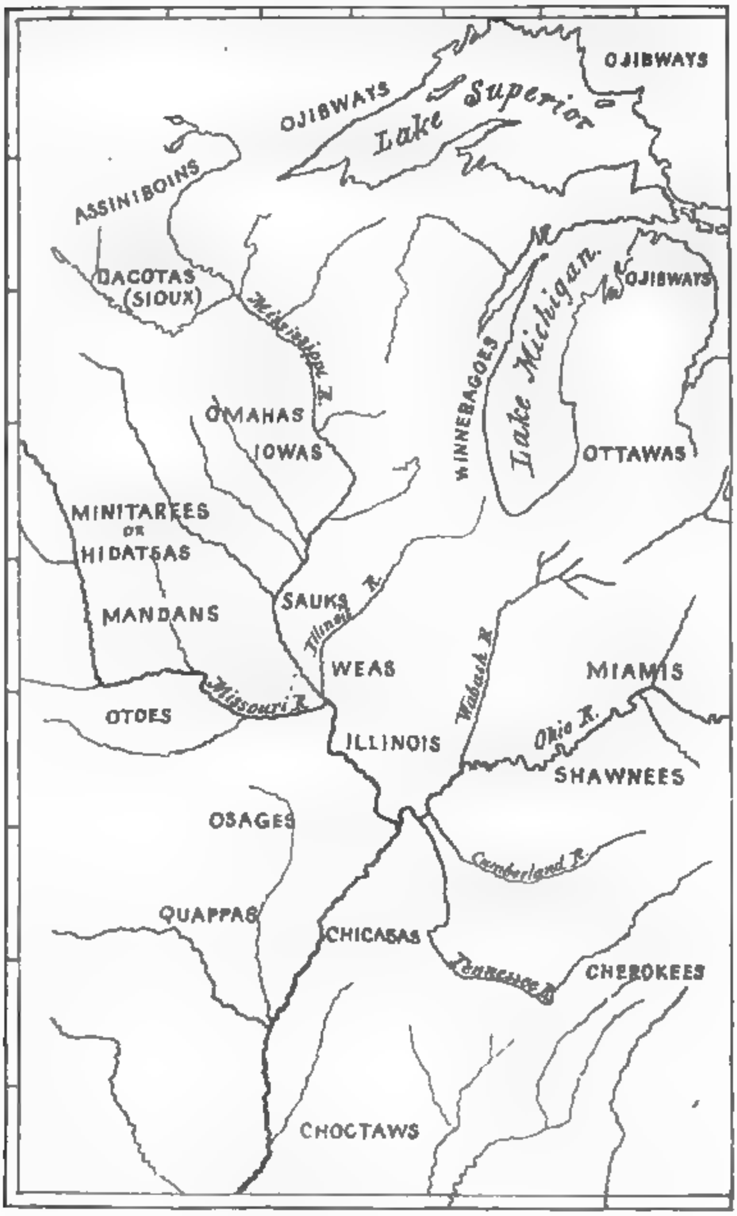
Mr. Claypole was introduced and took his seat.

A photograph of Prof. G. H. Cook was presented for the Album.

Prof. P. E. Chase accepted his appointment to prepare an obituary notice of Daniel B. Smith.

Letters of acknowledgment were received from the Holland

[*Continued on page 48.*]


OJIBWAYS
OJIBWAYS
Lake Superior
ASSINIBOINS
DACOTAS
(SIOUX)
Mississippi R.
OJIBWAYS
Lake Michigan
WINNEBAGOES
OMAHAS
IOWAS
OTTAWAS
MINITAREES
OR
HIDATSAS
SAUKS
Illinois R.
MANDANS
WEAS
Wabash R.
MIAMIS
Missouri R.
OTOES
Ohio R.
ILLINOIS
SHAWNEES
OSAGES
Cumberland R.
QUAPPAS
CHICASAS
Tennessee R.
CHEROKEES
CHOCTAWS


OJIBWAYS
HURONS
St. Lawrence River
Quebec.
ABENAKEES
Ottawa R.
Montreal
ALGONKINS
Georgian Bay
Lake Huron.
HURONS
L. Ontario
Brantford
1780
ONEIDAS
MOHAWKS
SENECAS
CAYUGAS
ONONDAGAS
1760
MASSACHUSETTS
Lake Erie
ERIES
Alleghany R.
CONESTOGAS
ANDASTES
MOHICANS
Mountains.
New York.
1745
DELAWARES
Philadelphia
Ohio R.
Alleghany
or Blue Ridge.
Washington
Susquehanna
Kenawha
Big Sandy
Cumberland, or
James R.
1671
Black Mounts.
1722
TUTELOS
Roanoke R.
TUSCARORAS
Neuse R.
1701
CHEROKEES
CATAWBAS
Cape Fear R.
Savannah R.
CREEKS
Charleston.
A Sketch Map
showing the stations & direction
of the
Tutelo Migrations
between
A.D. 1671 and 1780.
Horatio Hale.
Proc Amer Phil Soc. 1883.

Society (110, 111); the Fondation Teyler (111); and the Statistical Society of London (110, 111).

Letters of envoy were received from the Trigonometrical Survey of India, March 13th; the Central Observatory and the Botanic Garden at St. Petersburgh; the Musée Guimét; and the Meteorological Observatory at Cordoba, S. A.

Donations for the Library were received from the Royal Academy at Rome; the Société de Géographie; the Revista Euskara; London Nature; the Canadian Naturalist; Boston Natural History Society; Mr. J. R. Stanwood, Boston; Mr. S. A. Green, Groton; the Pennsylvania Historical Society; Pharmaceutical Association; Mr. Henry Phillips, Jr.; Mr. Albert S. Gatschet; Prof. H. Carvill Lewis; the U. S. Museum; U. S. Fish Commission; Mr. A. G. Bell; the American Antiquarian; University of Michigan; and Argentine Observatory.

The death of Jos. J. Lewis, of Westchester, April 6, aged 81, was announced by Mr. Fraley.

Prof. H. S. Williams of Cornell University, communicated a paper "On a Crinoid with movable spines," through Prof. Claypole, who explained the subject.

Prof. Claypole described a downthrow fault of 3500 feet, South of New Bloomfield, Perry county, Pa., and showed how the errors in the colored geological map of that county should be corrected.

Pending nominations, Nos. 979, 981 to 985 were read, and Nos. 979, 981 to 983 were balloted for.

Proceedings of the Society from 1744 to 1837, as condensed by the Librarian, were ordered to be printed, on the recommendation of the Committee of Five, the report of which was presented by Mr. Phillips, with estimates of cost, &c. On motion of Mr. Phillips the Secretaries were authorized to publish in *fac simile* the letter of Franklin, 1774, with which the records commence.

Mr. Fraley reported that he had received and paid over to the Treasurer $132.48, being the interest on the Michaux French rentes due April 1.

On examination of the ballot boxes by the presiding officer,

the following persons were declared to be duly elected members of the Society:—

Prof. Angelo Heilprin, of Philadelphia.
Mr. Ambrose E. Lehman, of Philadelphia.
Mr. Dillwyn Parrish, of Philadelphia.
Mr. Phillip C. Garrett, of Germantown, Philadelphia.
Mr. Elisha Kent Kane, C. E., of Philadelphia.

And the meeting was adjourned.

Mediæval Sermon-Books and Stories. By Professor T. F. Crane, of Ithaca, New York.

(Read before the American Philosophical Society, March 16, 1883.)

It is the object of this article to direct attention to an important source of mediæval history which has long remained neglected. We allude to the great collections of stories made chiefly for the use of preachers, which, besides giving a picture of the culture of the later middle ages, such as can nowhere else be found, throw a flood of light upon the diffusion of popular tales.* Before considering these specific works, we shall examine briefly several other collections, also having a moral scope, but intended for the edification of the general reader. From the present article are excluded the Western translations of Oriental story-books, even where they approach the specifically Christian collections as closely as does the *Disciplina Clericalis* of Petrus Alfonsi.†

Until the beginning of the twelfth century, the literature of the class to which the adjective entertaining may be applied, was almost exclusively Christian and legendary. There still survived, it is true, historical and mythological reminiscences of the classical period, but these secular elements

* Thomas Wright, Latin Stories (Percy Society, Vol. viii), pp. vii-viii, first, to our knowledge, called attention to this subject. See also K. Goedeke, *Every Man, Homulus und Hekastus*, Hanover, 1864, p. viii; and *Orient und Occident, Eine Vierteljahrsschrift, herausgegeben von* T. Benfey, i, p. 531 (*Asinus vulgi*).

† The literature of the subject will be mentioned *passim*, but a few recent works of general interest may be noticed now, and hereafter they will be cited by the authors' names alone. A. Lecoy de la Marche, *La Chaire française du moyen âge, spécialement au treizième siècle, d'après les manuscrits contemporains, Ouvrage couronné par l'Académie des Inscriptions et Belles Lettres.* Paris, 1868; L. Bourgain, *La Chaire française au XII^e siècle, d'après les manuscrits*, Paris, 1879; R. Cruel, *Geschichte der deutschen Predigt im Mittelalter*, Detmold, 1879. A good survey of the French field will be found in C. Aubertin, *Histoire de la Langue et de la Littérature française au moyen âge*, Paris, 1876–1878, Vol. ii, pp. 296–386, and a review of Lecoy de la Marche's work may be found in the *Revue des deux Mondes*, 15. Aug., 1869, *Les Sermons du Moyen Age*, by Aubry-Vitet.

were swallowed up in the vast legendary cycles of the Church.* This slender stream, was, however, about the time of the Crusades, swollen by a torrent of Oriental fables and stories, which maintained their supremacy in the learned world until the Revival of Letters, and then became the cherished patrimony of the illiterate classes, and still delight the people of all Europe.† The influence of this Oriental element upon the literature of the West was profound, affecting its form, and contributing a mass of entertaining tales which owe their diffusion and popularity largely to their absorption into the various later Occidental story-books. The literature of which we are speaking would have remained unknown to the people, had they been compelled to make its acquaintance by reading. Fortunately, there existed an ecclesiastical channel by which some scanty rills of a literature not exclusively ecclesiastical trickled among the people, and this channel, curiously enough, was the pulpit. The origin, mode, and matter of this oral diffusion will constitute the subject of the present article, after the ground has been cleared by a rapid survey of three characteristic works which form a group by themselves.

The method of instruction by figures, parables, apologues and the like, is too old to be referred to Christian symbolization of classic mythological elements.‡ This undoubtedly gave a specific development to the existing tendency, and resulted in the mediæval *bestiaires* and *lapidaires*. The employment of fables for serious didactic purposes is also Oriental, and all students of later mediæval literature know the vast influence of the Pantschatantra in its various versions. The earliest one which could have any influence on the Orient was the Latin translation by Johannes de Capua, *Directorium humanæ vitæ*, made between 1263–78, and based on the Hebrew version of Rabbi Joel (1250). The so-called Esopian fables were preserved in the paraphrase of Romulus, the existence of which as early as the tenth century has been clearly proved by Oesterley.§ It is all the stranger, then, that the earliest distinctively mediæval collection of fables shows no traces of a specific Oriental or classic influence—we refer to the *Speculum Sapien-*

* For the popularity of Valerius Maximus, to which we shall later recur, see Kempf's edition, Berlin, 1854, pp. 47 *et seq.*, and for mythological reminiscences in the poems of the Troubadours, see Diez, *Die Poesie der Troubadours*, Zwickau, 1826, pp. 127, 140, and Birch-Hirschfeld, *Ueber die den provenzalischen Troubadours des XII. und XIII. Jahrhunderts bekannten Epischen Stoffe*, Halle, 1878, *ad init.*

† It is not true that Oriental fiction was *introduced* into Europe by the Crusades; not only had the transmission been going on at a much earlier date (see Benfey's *Pantschatantra*, Leipzig, 1859, Vol. i, p. xxii), but the earliest Oriental collection, the *Disciplina Clericalis* of Petrus Alfonsi, was probably written before the first Crusade, quite certainly before 1106, the date of the Jewish author's conversion to Christianity.

‡ See Bartoli, *Storia della letteratura italiana*, Florence, 1878, Vol. i, p. 83, who attributes the above origin to the mediæval moralizations. We are more inclined to trace it to the influence of the Orient.

§ *Romulus: Die Paraphrasen des Phædrus und die Æsopische Fabel im Mittelalter*, von H. Oesterley, Berlin, 1870.

tiae attributed to a certain Bishop Cyril.* Who Bishop Cyril was is not known, and Græsse is compelled to refer the work to a certain *Cyrillus de Quidenon poëta laureatus*, a Neapolitan from Quidone, a small town in the province of Capitanata, in the kingdom of Naples, who flourished in the XIII century. He was a learned theologian, as Græsse remarks, who has taken the trouble to note the numerous passages cited from the Bible, and he was also an acute scholastic philosopher. He was not acquainted with Æsop, and from a remark he makes in Book I, cap. 18. it is evident he knew no Greek. His work is of little importance for the history of mediæval fiction, for it exerted not the slightest influence.† It is, however, interesting in itself, and was translated into German, Spanish, and Bohemian. The author, in the prologue, makes an elaborate apology for the form of his work. This is so characteristic of this class of writings that we quote a few lines which may also give some idea of the author's extraordinary style. He says: "Secundum Aristotelis sententiam in Problematibus suis quamquam in exemplis in discendo gaudeant omnes, in disciplinis moralibus hoc tamen amplius placet, quoniam structura morum ceu ymagine picta rerum similtudinibus paulatim virtutis ostenditur, eo quod ex rebus naturalibus, animalibus, moribus et proprietatibus rerum quasi de vivis imaginibus humanæ vitæ qualitas exemplatur. Totus etenim mundus visibilis est schola et rationibus sapientiæ plena sunt omnia. Propter hoc, fili carissime, informativa juventatis tuæ documenta moralia non de nostra paupertate stillantia sed de vena magistrorum tibi nunc scribere cupientes cum adjutorio gratiæ Dei ea trademus, ut intelligas clarius ac addiscas facilius, gustes suavius, reminiscaris tenacius per fabulas figurarum." A glance at the contents of the book will show that the learned author was more concerned with the moral of his fables than with the fables themselves.‡ No attention, except in a few rare cases, is paid to the nature of the animals brought upon the scene, and they are made to utter the most arbitrary and incongruous lessons. A translation of one of

* This singular work has recently been made accessible to scholars by the edition in the *Bibliothek des litterarischen Vereins in Stuttgart, Bd.* 148, *Die beiden aeltesten lateinischen Fabelbücher des Mittelalters, des Bischofs Cyrillus Speculum Sapientiae und des Nicholaus Pergamenus Dialogus Creaturarum, herausgegeben von* Dr. J. G. Th. Græsse. The full title is: *Speculum Sapientiae Beati Cirilli Episcopi, alias Quadripartitus Apologeticus vocatus, in cujus quidem Proverbiis omnis et totius Sapientiae Speculum claret.* The book had become very rare and was known chiefly from an old German translation, selections from which were published as late as 1782: *Fabeln nach D. Holtzmann, herausgegeben von* A. Gl. Meissner, Leipzig. 4to. Græsse has given in his edition, pp. 285–302, all the necessary biographical and bibliographical notices.

† Græsse, *ed. cit.*, p. 291, says, "Im Mittelalter selbst kann er von seinen Zeitgenossen nicht benutzt worden sein, denn ich habe nirgendswo in den aus dem 13.-16. Jahrhundert erhaltenen Schriften sein Werk citirt oder benutzt gefunden."

‡ In this respect there is a regular gradation in the three works now under consideration. In the *Speculum Sapientiæ* the moral is the all-important thing, in the *Dialogus Creaturarum* the fable becomes more attractive, while in the *Gesta Romanorum* the story is everything, and the moralization is tacked on merely to justify a sometimes very loose anecdote.

Cyril's apologues will be the best illustration of his peculiarities. We have selected one of the shortest, which is introduced by the sentence, *Uni dilectissimo tantum, cum necesse fuerit, pectus crede.* The Raven and the Dove, Book I, cap. 20. "While a raven was ruminating in his mind to whom he could occasionally communicate the secret of his heart, a dove beholding him thinking these things, approached him, saying: 'What art thou thinking, brother, in such deep meditation?' To whom he replied: 'Verily, I am now thinking that infinite is the number of fools and small indeed that of the wise, for the thought of the heart itself is most secret. For who reveals what he thinks, shows his heart. What, therefore, art thou, that I may give and entrust to thee my heart so precious to me, my most hidden life, my very inmost substance, the most secret root of my being? My secret is mine, because my heart is mine!' Then the dove, having heard these things, added: 'I know, indeed, that thou art cunning by nature. Wherefore I ask thee, brother, to instruct me, to how many and to whom, if it be necessary, I may safely entrust my heart at times.' He soon consenting, willingly said: 'Forsooth, either to one or to none, for perfect faith is seldom found. This, however, is made a very precious vase, for in it the heart is advantageously preserved, because neither of itself is it ever destoyed, nor broken by the sword or other thing, nor is its wonderful solidity transfixed by the most subtle sting of heat. For nature hides the vein of gold in the secret places of the earth, and the plant strikes its quickening root deep in the solid ground. Thus the most precious marrow is hidden in the bones, and God has placed the ice-like gem of sight under the hemispheres of seven veils. No wonder then that the mouth of the wise is hidden in his heart, since this is to him most dear, that thus it may be concealed and, possessed by the heart, hidden in the ark of life. But the heart of the fool is in his mouth, because the mouth rules his heart, and having an open breast despising the heart, it is easily cast forth by a slight breath, wherefore he quickly perishes, since for nothing he casts away the vein of life.' After she had diligently noted these things, the dove thus instructed departed."

The *Speculum Sapientiae*, as we have already said, is of little value for the history of mediæval fiction or the diffusion of popular tales. Scarcely a thing to which the adjective fabulous will apply, is to be found in the work. Græsse mentions only the story of Gyges (iii, 4), the Indian gold mountains (iii. 10), and the death of the viper (iii, 26; iv, 8, 10), which is found in all the *bestiaires*.* Cyril does not seem to be acquainted with Aesop, although the fourth chapter of the first book, *De cicada et formica* is Esopian. There are also some fox fables (e. g. i, 24) which resemble some of the episodes of the *Roman du Renart*, and a number of the fables have a certain similarity to those in well-known collections.†

* See, for example, Dr. G. Heider, *Physiologus*, Wien, 1851, p. 28, and the *Bestiaire de Gervaise* in the *Romania*, i, p. 420, *et seq.*, verse 501.

† Græsse's references, p. 291, are full of errors: La Fontaine i, 1, = Cyril i, 4; i, 22 = ii, 14 (cp. iii, 13); i, 2 = ii, 15 (the fox praises the singing of the cock, who

Of much greater literary interest, although by no means so profound or original, is the *Dialogus Creaturarum* of an otherwise unknown author, Nicolaus Pergamenus.* The form of this work closely resembles that of the *Speculum Sapientiae;* there is the same apologetic prologue, and the same arbitrary treatment of the subject, but already the desire to interest has assumed prominence, and the fable proper is followed by a mass of sentences, anecdotes, &c. The work contains one hundred and twenty-two dialogues not divided into books. The work, as Græsse (p. 303) shows, cannot be earlier than the middle of the XIV century. The writer, as a glance at the list of authors cited will show, was familiar with the whole range of mediæval literature, including the classic authors popular at that time.† He does not seem any more acquainted than Cyril with the great Oriental collections of fables as such, although separate fables from the Pantsohatantra may have reached him through western channels, as Græsse states, p. 304.‡ Instead of the half dozen fables in Cyril's work which may be compared with those of other collections, Nicolaus Pergamenus offers a rich field for the student of comparative storiology, if we may coin a convenient word. The absorption of Oriental elements into literature from oral tradition had already begun, and from literature, as we shall see later on in this article, these elements were to return again to the people, and thus the process was to be repeated over and over again until we are no longer surprised at the marvelous diffusion of mediæval stories.§ An English

thereupon descends from the tree and is devoured); vii, 12 = iii, 4; iii, 17 = iii, 11. His other references are incorrect. We have noticed the following: La Fontaine. ii, 19 = i, 18, 16 (slightly); ii, 11 = i. 18; ix. 4 = ii, 14 (cp. iii, 13). The edition of La Fontaine cited in this article is, *Fables inédites des XIIe, XIIIe et XIVe siècles, et Fables de La Fontaine rapprochées de celles de tous les auteurs qui avoient, avant lui traité les mêmes sujets, précédées d'une notice sur les Fabulistes, par* A. C. M. Robert, 2 vols., Paris, 1825. This edition will be hereafter cited as Robert, *Fables inédites*, or La Fontaine.

* This work is reprinted in Vol. 148 of the *Stuttgart Litt. Vereins*, mentioned above.

† The list given by Græsse, p. 281, needs careful revision. The following are some of the most necessary corrections: Alfonsus (that is Petrus Alfonsi *Disciplina Clericalis*). *De Prudentia*, 122, add 56; add *Catholicon* 90; add *Nugis philosophorum*, 23, 115; add Martialis, 108 (instead of 109).

‡ It may perhaps be noted here that La Fontaine's well-knowh fable of *La Laitière et le Pot au Lait* is found in the *Dialogus Creat.*, c. 100. Max Müller (Chips., iv, 170) gives the old English translation of this version, and says: "In it, as far as I can find, the milkmaid appears for the first time on the stage," &c. The version in Jacques de Vitry and Etienne de Bourbon, which will be mentioned later, must be both of them earlier, or as early, and it is probable that in this case, as in so many others, Jacques de Vitry introduced the fable to Europe. A pleasant account of the fortunes of this fable may be found in *Histoire de deux Fables de La Fontaine, leur origines et leurs Pérégrinations, par* A. Joly, Paris, 1877. The other fable is vii, 1, *Les Animaux malades de la Peste.*

§ The following corrections and additions to Græsse's references, p. 304, will be of use to the student. References XXXI, XXXIV, and XLVI belong to XXX, XXXIV and XLVII, respectively; add XLIII, Pauli, 256; the references to XXXVI and XL are incorrect; of the various references given to XLVI (should

translation of the *Dial. Creat.* was published about 1517 and reprinted in a limited edition in 1816.

The third work to be mentioned in this connection is the well known *Gesta Romanorum.* We do not propose in this limited space to approach the still vexed question of the date and nationality of this famous work.* Its importance is not great in the abstract, the number of stories valuable for the *Culturgeschichte* of the middle ages is small, but the part the work has played in the transmission of a vast body of classical and Oriental tales is enormous. Already the morality has been swallowed up in the story, and the aim is to amuse under the pretext of instruction. Other similar collections will be noticed, later out-growths of the homiletic compilations, but the *Gesta Romanorum* stands alone, an independent and original collection, the earliest Occidental effort to throw off the shackles of purely ecclesiastical entertaining literature. The three collections which we have just briefly considered are the only ones intended for the edification of the general reader, and it is only the third which reveals a growing taste that before long was satisfied by Boccaccio and the French *fabliaux,* or by such purely secular collections as the Italian *Cento Novelle antiche.* The mass of material at the disposal of the collector in the XIII and XIV centuries was enormous, besides the vast compilations of legends in the *Vitae Patrum* and *Legenda Aurea,* there were the relics of classical lore, and the new flood of Oriental fiction, both written and oral. In addition to all this, a tendency now shows itself to collect anecdotes, etc., of famous contemporaries. Much of the above material would have perished, and certainly the circle of its influence would have been comparatively narrow, had not a new need made itself felt, and a new market, so to speak, been opened for these wares.

The duty of public preaching, which, at first was reserved for the bishops, was extended later to the priests, but it was for a long time a privilege jealously guarded and restricted to comparatively few. The

be XLVII) La Fontaine, vii, 16, is alone correct; to LXXXIX add *Gesta Rom.*, 29; to XCIII, *Schluss*, add *Gesta Rom.*, 103; the references to C are to three different stories: I "Bird in the hand," *Gesta Rom.*, 467; Kirchhof, iv, 34; II "Dog letting go meat for reflection in water," Pauli, 426; III "*La Laitière et le Pot au Lait*," La Fontaine, vii, 10, Kirchhof, i, 171; the reference to Cl. *Gesta Rom.*, 108, is incorrect: both references to CVI are incorrect; of those to CVIII, *Gesta Rom.*, 140, is incorrect, as is also La Fontaine, v, 21; to CX (cp. xliv), La Fontaine, iii, 9, is incorrect; CXII contains two fables: I "*Colombæ et Milvi*," and II "Town and Country Mice," to I belongs Kirchhof, 7, 146, to II Kirchhof, 1, 62, and La Fontaine, i, 9, erroneously referred to CXIII; to CXVII add La Fontaine, iii, 9; to CXVIII, *Gesta Rom.*, 53, instead of 52, other references are incorrect; finally to CXXII add Petrus Alfonsi, p. 83, ed. Schmidt, and *Gesta Rom.*, 31.

*It should seem that little remained to be done after Hermann Oesterley's masterly edition (Berlin, 1872), but the results of his painstaking investigations are chiefly negative. It may be impossible to determine its nationality, but it seems as if more light might be thrown on its age and mode of compilation. The results of Oesterley's studies are given to the English reader in the Introduction to the Early English Versions of the Gesta Romanorum (Early English Text Soc. Extra Series, xxxiii, 1879).

foundation in the XIII century of the two great orders of Dominicans and Franciscans, the former, *par excellence* the *ordo prædicatorum*, gave an enormous impulse to preaching and quite changed its character.* The monks of these orders obeyed literally the words of the Founder of Christianity, and went into all the world and preached the Word to every creature. The popular character of the audiences modified essentially the style of the preaching. It was necessary to interest and even amuse the common people, who, as we have incidentally shown, were becoming accustomed to an entertaining literature more and more secular, and who possessed moreover an innate love for tales. It is chiefly to this fondness for stories and to the preachers' desire to gratify it that we owe the great collections of which we are about to speak. In the composition of the mediæval sermon, which had, moreover, a certain fixed form, the stories, or, to give them the name they then bore, and which we shall use hereafter, *exempla*, were reserved for the end, when the attention of the audience began to diminish.† The value of these *exempla* for awakening the attention and instructing the people is everywhere conceded.‡ These stories are sometimes as long as the rest of the sermon, sometimes, when they refer to a well-known recital, they merely quote the title or a few words of the beginning. The use of *exempla*, properly speaking, is rare before the XIII century (L. de la Marche, p. 276), and was apparently first introduced as a principle by Jacques de Vitry. This eminent prelate and scholar was born in the early part of the last half of the XII century, and took his name either from the village of Vitry on the Seine near Paris, or from a town of the same name on the Marne in Champagne. He studied in Paris from 1180–90, and became a *presbyter parochialis* at Argenteuil near Paris. In 1210 he went to Brabant and became a canon at Villebrouck and afterwards at Oignies, where he was the intimate friend of the enthusiast, Mary of Oignies, whose life he wrote after her death in 1213. From 1210–1217 he preached the crusade against the Albigenses, and took part in the

* The relative importance of these orders may be inferred from the fact that of two hundred and sixty-one French preachers of the XIII century ninety-one were Dominicans and forty-five Franciscans; see Aubertin, ii, p. 308, n. 3.

† In fine vero, debet uti exemplis, ad probandum quod intendit, quia familiaris est doctrina exemplaris, Alanus de Insulis, *Summa de arte prædicatoria*, cap. I, ed. Migne, p. 113.

‡ Herolt in the Prologue to his *Promptuarium Exemplorum* says: "Utile et expediens est viros predicationis officio preditos proximorum salutem per terras discurrendo quærentes exemplis abundare. Hæc exempla facile intellectu capiantur et firmiter memoriæ imprimuntur et a multis libenter audiuntur. Legimus enim principem nostrum Dominicum ordinis prædicatorum fundatorem hoc fecisse. De eo quidem scribitur quod ubicumque conversabatur edificatoriis effluebat sermonibus, abundabat exemplis quibus ad amorem Christi sæculi ve contemptum audientium animos provocabat." Etienne de Bourbon in the Prologue to his treatise, says: "Quia autem ad hec suggerenda et ingerenda et imprimenda in humanis cordibus maxime valent exempla, que maxime erudiunt simplicium hominum ruditatem, et faciliorem et longiorem ingerunt et imprimunt in memoria tenacitatem."

expedition. After the capture of Narbonne in 1217 he was made Bishop of Accon (Acre) in Palestine, where he remained, taking an important part in the crusades. In 1227 he returned to Rome, and between 1228–30 was made a cardinal and Bishop of Tusculum by Gregory IX, who employed him on several missions. He was offered the patriarchate of Jerusalem, but refused it, and died at Rome in 1240.* He is chiefly known by his *Historia orientalis* which extends from 622–1218. We are, however, especially interested in his sermons. We have seen above that he was an enthusiastic preacher of the Albigensian crusade, and Etienne de Bourbon says of him: "Vir sanctus et litteratus * * * prædicando per regnum Franciæ et utens exemplis in sermonibus suis, adeò totam commovit Franciam, quòd non putat memoria aliquem ante vel post sic novisse." His printed sermons (Antwerp, 1575) are what are technically known as *Sermones de tempore et sanctis*, and are distinguished from the mass of sermons of that day by the use of less scholastic argument and more examples borrowed from history and legend. His unpublished sermons (*Sermones vulgares*) are, as L. de la Marche says, literally crammed with stories, and constitute a treasure house which succeeding preachers have pillaged, often without any acknowledgment. L. de la Marche says, p. 276, that each sermon contains three or four *exempla* in succession. The more simple and common the audience the more prodigal he is of his stories. He says himself, in his preface: "The keen sword of subtle argumentation has no power over the laymen. To the knowledge of the Scriptures, without which one cannot take a step, must be added examples which are encouraging, amusing and yet edifying. Let us lay aside the pagan fables and poetry which do not afford any moral instruction; but let us open the door to the maxims of the philosophers which express useful ideas * * * * * * The inexperienced who blame this mode of preaching do not suspect the profit it may produce; for our part we have tried it." He then continues relating how he excited the attention of his hearers: "Such an example," he says, "seems dull when read, which, on the contrary, will be very pleasing in the mouth of a skillful narrator." †

* See *Histoire littéraire de la France*, *XVIII*, 209 *et seq.*, Græsse, *Lehrbuch einer allgemeinen Literärgeschichte*, ii. Bd., iii. Abth., ii. Hälfte, p. 1058, and Gœdeke in *Orient und Occident*, i. 541.

† L. de La Marche, *op. cit.* pp. 276–277, who adds: "Les extraits, les reproductions diverses qui furent faites de ses œuvres presque immediatement prouvent combien son idée eut de succès. À quel point elle s'adaptait aux besoins des populations." It was for a long time supposed that Jacques de Vitry was the author of a *Speculum Exemplorum* (see Gœdeke, *op. cit.* p. 542); this is not the case, his *exempla* are found in his inedited sermons. It is greatly to be wished that L. de la Marche who has so ably edited Etienne de Bourbon would do the same for Jacques de Vitry, whose importance for the diffusion of popular tales is greater than that of any writer we shall have occasion to mention in the present article. How much this writer was used by other preachers will appear when we consider later Etienne de Bourbon's obligations to him. Gœdeke in the article above cited mentions another case of wholesale borrowing, that of the monk Johannes Junior in his *Scala coeli*.

Jacques de Vitry was followed by Etienne de Bourbon, whose collections will be examined later in detail, and other writers of this period recommend the frequent use of *exempla*.* The abuses which arose from the excessive use of *exempla* were great, and the Council of Sens in 1528 forbade under the pain of interdict "those ridiculous recitals, those stories of good wives (*aniles fabulas*) having for their end laughter only."† These *exempla* at first were probably collected by each preacher for his own use, then the collected sermons of such celebrated *raconteurs* as Jacques de Vitry offered an inexhaustible magazine for several generations. Finally special collections of these *exempla* were made for the express purpose of aiding the preacher, and it is to these and similar collections that the remainder of this article will be devoted. The wealth of material can be indicated but incompletely in the limited space at our command, and we shall therefore select as illustrations a few typical works from the various classes into which the literature of the subject may be divided. In the first place stand the collections containing *exempla* alone, arranged either alphabetically or topically. We shall make use of one of each class, viz., the *Promptuarium Exemplorum*, and the *Speculum Exemplorum*, and refer briefly to later imitations in the modern languages of these collections. In the second place come treatises for the use of preachers, containing stories systematically arranged, but forming only a part of other homiletic material. Three of these works will demand our attention: Etienne de Bourbon, *De Septem Donis;* Peraldus, *Summa Virtutum et Vitiorum;* and Bromyard, *Summa Praedicantium*. A third source of *exempla* is to

* L. de la Marche, p. 277, cites Humbertus de Romanis, *De Eruditione praedicatorum*. Bibl. Max. Pat. xxv, 433. We have examined all the similar treatises at our disposal, such as Alanus de Insulis, *Summa de arte praedicatoria;* Petrus Cantor, *Verbum Abbreviatum*, and Guibert de Nogent *Liber quo ordine Sermo fieri debeat*, and only in the first named work have we found a brief reference to *exempla* which we have cited above.

† L. de la Marche, p. 278. The reader will recall Dante's passionate outbreak against the preaching of his day (Paradise, xxix, 103–120, Longfellow's translation):

Florence has not so many Lapi and Bindi
As fables such as these, that every year
Are shouted from the pulpit back and forth,
In such wise that the lambs who do not know,
Come back from pasture fed upon the wind,
And not to see the harm doth not excuse them.
Christ did not to His first disciples say,
"Go forth, and to the world preach idle tales."
But unto them a true foundation gave;
And this so loudly sounded from their lips,
That, in the warfare to enkindle faith,
They made of the Evangel shields and lances.
Now men go forth with jests and drolleries
To preach, and if but well the people laugh,
The hood puffs out, and nothing more is asked.
But in the cowl there nestles such a bird,
That, if the common people were to see it,
They would perceive what pardons they confide in.

be found in collections of sermons made for the benefit of idle or ignorant preachers. Two of these collections will be examined: the sermons of Herolt, already mentioned as the author of the *Promptuarium*, and those of Pelbartus of Themesvar; and finally a brief reference will be made to the class of expository works of which one of the most celebrated, Holkot, *Super Sapientiam*, may stand as an example.

The author of the *Promptuarium Exemplorum* was Johannes Herolt, a Dominican monk of Basel, who flourished during the first half of the XV century.* He whimsically called himself *Discipulus*, and his works are generally cited under that name. He himself explains it as follows at the end of the *sermones de tempore*: "Finiunt sermones collecti ex diversis sanctorum dietis et ex pluribus libris. Qui intitulantur sermones discipuli quod in istis sermonibus non subtilia per modum magistri, sed simplicia per modum discipuli conscripsi et collegi." Nothing is known of his life. Besides the works we have already mentioned he left a collection of *sermones super epistolas dominicales*, *Eruditorium Vitae*, a *Quadrigesimale* and a work on the Albigensian war. The *Promptuarium* begins with the usual apologetic prologue from which an extract has been given above, then follow six hundred and thirty-four *exempla* with references to two hundred and eighty-three contained in the sermons. This large mass of stories is arranged alphabetically by topics, *e. g. Abstinentia, Accedia, Adulterium, Amicitia, Acqua benedicta, Baptismus*, etc., and reference is also facilitated by a copious index. Before examining the collection in detail, it may be well to consider briefly its

* Scanty notices of him will be found in Fabricius, *Bib. lat. med.* (Florence, 1858), *sub verb. Discipulus*, Graesse, *Lehrbuch einer Literärgeschichte*, ii, 2, 1, p. 169, Cruel, p. 480, and Val. Schmidt in his edition of the *Disciplina Clericalis*, Berlin, 1827, p. 99, note 3. The date of the composition of his sermons is given in *Sermo LXXXV* (*in Dominica secunda post octavas Trinitatis*): *a Christo autem transacti sunt mille quadrigenti decem et octo anni*, but in the VI of the *Sermones de Sanctis*, he mentions as heretics, Huss, Jerome, and Procopius, the latter of whom did not assume the leadership of the Hussites until 1424, and was not killed until 1434 in the battle of Bœmischbrod. This discrêpancy can easily be explained on the supposition that Herolt inserted in his collection his earlier sermons, and either forgot to change the first date or purposely left it (Cruel, p. 480). The collection was probably published between 1435–40, and this will also be the date of the *Promptuarium*, as constant reference is made to it in the sermons and *vice versâ*, and its object was undoubtedly to afford the preachers who used the sermons, a wider range of *exempla*. We do not know whether any edition of the *Promptuarium* appeared separate from the sermons, but imagine not. The enormous popularity of the work (including both in one) may be seen by a glance at Hain and Panzer. The former mentions twenty-nine editions with place and date, and seven without, before 1500; the latter, fifteen editions after the above date. The edition cited in this article is Argentine, 1495, M. Flach, fol. (Hain, No. 8505). It contains the sermons which will be mentioned later, the *Promptuarium*, and a collection of miracles of the Virgin, filling thirty-one pages. There is an old French translation of the *Promptuarium*, *Fleur des Commandements de Dieu*, Rouen, 1496, Paris, 1525, 1536, 1539, and a later arrangement by another Dominican, Aug.-Vind., 1728, 4to, *Discipulus Redivivus*, etc., *collecta a* Bonav. Elers, *Ord. Pr.*

sources, for, as can well be imagined, such a collection could only be a compilation, nor does the author, as we have seen, make any claim to originality.* Herolt himself mentions the following: Arnoldus (Geilhoven *de Roterodamis*, author of *Gnotosolitus sive Speculum conscientiae*); Beda (*Gestis Anglorum*); Caesarius Heisterbacensis (*Dialogus Miraculorum*); Gregorious (Gregory I, *Dialogi*); Gregorius Turonensis; Gulielmus (Thomas Cantinpratensis, *Liber de apibus*); Gulielmus Lugdinensis (Peraldus, whose *Summa virtutum et vitiorum* will be examined later); *Historiis Britonum* (Geoffrey of Monmouth); *Historia ecclesiastica;* Holgot (Robert Holkot whose *Liber super Sapientiam* will be examined later); Hugo de St. Victor; Isidorus; Jacobus de Vitriaco (Jacques de Vitry); *Liber de donis* (Etienne de Bourbon, to be mentioned hereafter); Petrus de St. Amore; Petrus Cluniacenses; Vincentius (of Beauvais, *Speculum historiale*); Viridarius;† *Vitae Patrum* and Zosimas.‡ To this list may be added Jacobus de Voragine whose *Legenda aurea* is frequently used without acknowledgment, and some Oriental sources which will be mentioned later. The ecclesiastical character of Herolt's collection is evident at a glance. The compiler gathered his material largely from a few writers like Caesar of Heisterbach, and does not draw upon his own experience like Etienne de Bourbon. There are only two or three fables, and but few traces of the earlier Oriental collections. The *Disciplina clericalis* contributes four stories: M. 67 = ed. Schmidt, p. 106; S. 5 = Schmidt, p. 46; V. 12 = Schmidt, p. 51; *Sermones de tempore*, 120 = Schmidt, p. 36. There are other Oriental elements as we shall afterwards see, one may be mentioned here, the story in Barlaam and Josaphat, c. 29, which furnished Boccaccio with a well-known tale (Dec. iv, introduc.), is found in Herolt, L. 24. We shall relegate to the notes a few widespread stories in order to show the value of the work for the diffusion of popular tales, and proceed to characterize briefly the more original part of the work.§ Of original historical anecdotes there is scarcely

* Fabricius gives a very incomplete list of Herolt's sources, which is somewhat increased by Mansi in the Florentine edition of 1858.

† We are not acquainted with this work, but the *Speculum exemplorum* cites a work, *Viridarium sanctorum ex Menaeis Graecorum translatum*. We must confess and deplore our distance from a large library of reference, which prevents our settling some doubtful points in the present essay, the materials for which are drawn almost exclusively from our own private library. Our thanks are, however, due to the library of the Auburn (N. Y.) Theological Seminary which, with the utmost liberality, put at our disposal its copy of Migne's *Patrologia*.

‡ Of the above, Arnoldus, Cæsarius, Gregory, Gulielmus (Cantinpratensis), and the *Vitæ Patrum* furnish about two hundred exempla or nearly one-third of the whole.

§ A. 13 B (Pauli, 260); A. 15 (*Gesta Rom.* 188); A. 18 (Pauli, 93); B. 9 (*Gesta Rom.* 45); C. 32 (*Gesta Rom.* 48); C. 39 (*Leg. aurea* 142); C. 40 (Pauli, 278); D. 3 (Pauli, 546); E. 5 (Pauli, 140); E. 6 (Wright's Latin Stories, 65); E. 12 (*Wendunmuth* 5, 127); F. 2 (Pauli, 391); F. 6 (Pauli, 683); F. 15, 16 (Pauli, 436); F. 17 (Pauli, 435); J. 16 (Pauli, 692); I. 33 (Pauli, 647); I. 38 (Pauli, 129); I. 39 (Pauli, 507); I. 40 (Pauli, 226); I. 41 (Pauli, 118); I. 42 (Pauli, 125); I. 43 (Pauli, 124). I. 44 (Pauli, 186); I. 49 (La Fontaine. Bk. I. 7); L. 3 (Pauli, 337); L. 21 (*Wendunmuth* I. 220); L. 35 (Pauli, 385);

an instance (A. 6; P. 123, 124). Comparatively little can be learned of the fashions of the day, a rubric so full and extensive in Etienne de Bourbon. In the eighty-third *Sermo de Temp.* (*De superbia vestium*), the long trails of the ladies of that time are bitterly censured, and a story told which is probably taken from Caesar of Heisterbach (Dial. V, 7, cp. Kaufmann's *Caesarius von Heisterbach, 2te, Aufl.* Cöln, 1862, pp. 40, 41, 114). The remainder of the stories, *i. e.*, those which may be regarded as original, so far at least as no source being cited—are the ordinary monkish tales, of which there must have been an enormous mass in circulation, and of which the best idea may be formed by a perusal of Caesar of Heisterbach's *Dialogus Miraculorum* (ed. J. Strange, Cologne, 1851. 2 vols.) From this hasty survey we see that Herolt's work does not possess the interest and value we should expect. It gives, it is true, a very complete picture of the low intellectual level of preacher and congregation, and so far is important, but it fails to reproduce the society of the day as is so vividly done in Etienne de Bourbon, for instance. The most valuable part of Herolt's collection is what he borrowed from others, and to which he gave a wider circulation, and this constitutes his chief interest for the student of comparative storiology.

The *Promptuarium*, as we have seen, was an appendix to the author's collection of sermons and intended to be used in connection with them. It was not long before some one conceived the idea of making an independent collection of *exempla* which could be used with any of the numerous sermon-books. The most famous of such independent collections is the *Spéculum Exemplorum.** The author's name and country are unknown, but from internal evidence he seems to have been from the Low Countries or the adjacent German provinces. The popularity of his work led a Jesuit of Duaci, Johannes Major, to remake the book by casting it into an alphabetical form and by a very free handling of the contents. He terms his work *Magnum Speculum Exemplorum,*† and justifies this name in his preface by saying it surpasses all previous collections in the number of its *exempla*, which the compiler states to be thirteen hundred and seventy-five. The source of the story is always given at the end, and there is an attempt at a bibliography of similar collections. The growing scientific spirit of the day is very amusingly illustrated in the preface, where an apology is made for the apparently incredible character of some of the stories, which, however,

M. 3 (Pauli, 81, 90); M. 17 (*Wendunmuth* I, 366); M. 18 (Pauli, 135); M. 22 (*Libro de los Enxemplos*, 23; *Romania*, No. 28, p. 497); M. 39 (*Gesta Rom.*, 273); M. 68 (*Gesta Rom.* 202); O. 12 (Pauli, 318); O, 13 (Pauli, 318); O, 14 (Pauli, 317); O. 23 (*Wendunmuth* 7, 17); P. 2 (Pauli, 471); P. 4 (Pauli, 471); S. 10 (Wright's Latin Stories, 84); T. 5 (Pauli, 281); T. 8 (*Wenduumuth* 2, 137, La Fontaine Bk. VIII, 2); T. 9 (*Wendunmuth* 2, 137); V. 14 (Pauli, 11); V. 41 (Pauli, 305); Y. 4 (Pauli, 665)?

* The first edition was printed at Daventer, in Holland, in 1481 (Hain, No. 14915), then followed editions of Cologne, 1485, Strasburg, 1487-90-95-97, and Hagenau, 1507-12-15-19.

† Duaci, 1605-7; Antwerp. 1607; Cologne, 1611-72. Our copy is Duaci, 1607. We have not been able to procure a copy of the original work.

if closely examined, will be seen to be possibly true, *e. g.*, the story of the obstinate woman thrown into the water, who could not speak but moved her fingers to represent a pair of scissors—here the collector naïvely adds: "Potuit enim daemon cuius rabiosá illa foemina praeda erat, ipsius articulos in eam formam composuisse." The increasing secular character of these works is indicated by another passage in the preface: "Deinde si qua incredibilia, vel fabulosa, vel tantum ad ciendum risum efficta videntur, qualia paucissima sunt, solum in navigiis, vehiculis, mensis vel iucundis congressibus narranda serventur." The scope of the work has been enlarged, it is no longer addressed exclusively to preachers, but to the "prudens concionator, cathecista vel narrator." We think we can also notice a distinct advance in the character of the stories; more historical incidents are introduced, and the number of puerile monkish stories is much smaller. Our space will not allow us to examine in detail this vast compilation; many of the stories in the *Promptuarium* are to be found in it, and it must have served to spread many stories at a time when the taste for the older collections was rapidly diminishing.* This is perhaps the most appropriate place to describe several collections in the vulgar tongues, which, so far as their scope goes, are purely secular. We mention these works here rather than in connection with the *Gesta Romanorum*, because they seem to us more appropriately classed here by their form. They are alphabetical, or arranged topically for convenience of ref-

* A work similar to the *Speculum Exemplorum* is, A. Davroult, Soc. Jes., *Flores exemplorum, in quo Fides Catholica poene innumeris et exemplis sanctorum, et vivorum illustrium probatissimis confirmatur.* Coloniæ, 1656, 1686, 4to. Other works of this class might be mentioned here, but we will merely call the attention of scholars to two collections of mediæval moralized tales described by the Vice-President of the Royal Irish Academy in a paper read before that body, April 10, 1882, and entitled, "On two Collections of Mediæval Moralized Tales," by John K. Ingram, LL.D., F. T. C. D., Dublin, 1882. These collections are found in MSS. belonging to the Diocesan Library of Derry. The first is in two parts, one containing *exempla* arranged topically; the other is arranged in alphabetical order, "and the subjects are illustrated not by stories or anecdotes, but by sentences quoted apparently from various authors." The second is entitled, *Speculum sive lumen laycorum.* The arrangement is alphabetically by topics. I cannot do better than quote Dr. Ingram's account of the sources used by the compiler. "The materials of the work are borrowed from a great variety of authors. The classical writers of antiquity are but little quoted; there are references to Aristotle—some of whose works were known through Latin versions—to Cicero, Horace, Valerius Maximus, and Seneca. But the sources on which the compiler has drawn most largely, are the writings of St. Augustine, especially the *De Civitate Dei*, the *Historia Tripartita* of Cassiodorus, the Dialogues of St. Gregory, the collection known as *Vitæ Patrum*, the curious treatise entitled *Barlaam and Josaphat*, various Lives of Saints, the *Disciplina Clericalis* of Petrus Alfonsus, and the works of St. Isidore of Seville, of Bede, of Jacobus de Vitriaco, of Peter of Clugny (otherwise known as Peter the Venerable), and of Jacobus de Voragine, author of the *Legenda Aurea.* * * * Some of the narratives appear to have been taken, not from books, but from popular rumor or tradition, commencing as they do with *Fertur* simply. In the moralizations very large use is made of the Old and New Testament, with the text of which the compiler seems to have been thorougly familiar."

erence. They are, of course, all outgrowths of the same spirit, but the works now under consideration, we think, owe more to the distinctively ecclesiastical collections than to the *Gesta Romanorum*. In 1860, Don Pascual de Gayangos edited for Rivadeneyra's *Biblioteca de Autores Españoles*, a volume (No. 51) of *Escritores en prosa anteriores al siglo XV*, pp. 447–542 of which contain *El Libro de los Enxemplos*, an alphabetical collection of three hundred and ninety-five stories. As the stories, however, begin with C (*Confessio devota debet esse et lacrymosa*) it is evident that the first part of the collection is wanting. This loss was repaired by A. Morel-Fatio who discovered the missing stories, seventy-one in number, and published them in the *Romania*, vii, pp. 481 *et seq*. The compiler was a certain Clemente Sanchez, Archdeacon of Valderos, in the diocese of Leon.* His chief sources are the *Disciplina Clericalis*, which he has incorporated almost entire in his work, *Vitae Patrum*, Dialogues of St. Gregory, and Valerius Maximus. The four furnish nearly one quarter of the whole number of stories. About twenty are taken from the *Gesta Romanorum*, or, at least, are found in that collection; many others are taken from the *Legenda Aurea*, and mediæval chroniclers. The number of stories referring to Greek and Roman history, or taken from classical sources is noteworthy. Each story is preceded by a Latin title which is translated in a Spanish distich which follows, and generally rhymes. The second of the alphabetical collections in a modern tongue is in the dialect of Catalonia, and was made prior to the XV century, or in the early years of the same.† The first volume, all published at present, contains three hundred and seventy stories, ranging from A to K. The stories are preceded by a Catalan title (not alphabetical) which usually mentions the source, then follow short Latin titles arranged alphabetically. The principal sources are: Jacques de Vitry, *Vitae Patrum*, Caesar of Heisterbach, Helinand, Valerius Maximus, Petrus Alfonsi, Etienne de Bourbon, *Legenda Aurea*, St. Gregory and Petrus Damianus. These alone furnish two hundred and forty-five stories, and afford a very clear idea of the general character of this collection.‡

We have thus traced rapidly this curious branch of our subject. Originally merely an appendix to a collection of sermons, then forming an independent work by themselves, but still with the purpose of furnishing the preacher with entertaining matter for his homilies, these stories finally

* See *Romania*, *loc. cit.*, and Nic. Antonio, *Bib. hisp. vetus*, ii, 208.

† *Recull de Eximplis e Miracles, Gestes e Faules e altres ligendes ordenades per A-B-C, tretes de un manuscrit en pergami del segle XV, ara per primera volta estampades* (no place or date, in fact, Barcelona, 1881, A. Verdaguer).

‡ Some extracts from a collection of edifying stories found in a Portuguese MS. of the XIV century have recently been published by J. Cornu in the *Romania*, xi, pp. 381–390. The stories, twenty-four in number, are drawn from the Bible, St. Gregory, the *Vitae Patrum*, etc. No. 9 is the famous parable of the Friends in Need (Barlaam and Josaphat, cap. 13, see *Gesta Rom.* ed. Oesterley, cap. 238). The stories are not alphabetically arranged, and no hint is given of the extent of the original work.

became, in their more modern dress, a pastime by no means unprofitable, for besides introducing secular elements into entertaining literature, they contributed to prepare the ground for the Revival of Letters by diffusing some remnants of classical lore. The general question of the bearing of these collections upon the subject of the diffusion of popular tales will be considered at the conclusion of the present article.

We have now to direct our attention to the class of treatises for the use of preachers containing *exempla* systematically arranged, but forming only a part of other homiletic material. In many respects the most interesting and valuable work of this class is the *Tractatus de diversis materiis praedicabilibus, ordinatis et distinctis in septem partes, secundum septem dona Spiritus sancti et eorum affectus, currens per distinctiones materiarum, per causas et effectus, refertus auctoritatibus et rationibus et exemplis diversis ad edificationem pertinentibus animarum*, by Stephanus de Borbone, usually cited as the *Liber de Donis* (in the *Recull de Eximplis* as *Libre de Dono Timoris* for a reason which will hereafter be apparent).* The author of this work was careful to conceal his name, and designates himself in the prologue simply as: "Ego, frater S., in ordine Fratrum Praedicatorum minimus." From a brief notice in the *Scriptores ordinis prædicatorum* (I, 184), it appears that the author was a certain Stephanus de Borbone (Etienne de Bourbon), born at Belleville-sur-Saône (department of the Rhône), a member of the Dominican order, who died about 1261 in a monastery of his order at

* Copious extracts from the above work have been published under the title, *Anecdotes historiques, Légendes et Apologues tirés du recueil inédit d'Etienne de Bourbon, dominicain du XIIIe siècle, publiés pour la Société de l'Histoire de France par* A. Lecoy de la Marche, Paris, 1877. The plan of the edition is thus stated by the editor in his introduction, p. xxv: "On ne trouvera pas non plus ici le texte intégral de tout le volumineux manuscrit d'Etienne de Bourbon; mais on y trouvera du moins un texte pur, et plus que des extraits. J'avais à faire un volume de documents historiques; j'ai donc pris tout ce qui pourait intéresser l'histoire, c'est-à-dire la plus grande et la meilleure partie de l'ouvrage, et, pour ainsi dire, sa moelle. En un mot, j'ai laissé de côté les réflexions morales. les passages de l'Ecriture et le commentaire théologique, n'en gardant que ce qui était indispensable pour faire comprendre le plan et la pensée de l'auteur, pour rattacher ensemble sa longue série d'examples, dont je ne pourais songer à intervertir l'ordre. Quant à ces examples eux-mêmes, j'ai dû en supprimer également un bon nombre, qui auraient grossi inutilement et démesurément ce volume. Voici la régle générale que j'ai suivie à cet égard: tout ce qu'Etienne a raconté *de visu* ou *de auditu*, c'est-à-dire ce qui s'est passé de son temps, et les faits antérieurs, authentiques ou légendaires, dont il a recueillé un récit oral, tout cela a été soigneusement conservé; les traits empruntés par lui à d'autres écrivains, ordinairement désignés, c'est-à dire la partie de son recueil qui n'est pas véritablement originale, ont été sacrifiés. Je n'ai fait que de rares exceptions, commandées par des raisons spéciales. Ainsi, je n'ai pas cru devoir rejeter les citations de certains auteurs contemporains de nôtre, et dont les écrits sont peu ou point connus; les historiettes assez nombreuses tirées de la collection de Jacques de Vitry, par example, ne pouvaient qu'ajouter un attrait de plus à l'édition." The notes to the separate stories are not as full as might be desired, and some of the most interesting parallels have been overlooked; some additions to these notes will be given when we consider the contents of the work.

Lyons. Further details are furnished in his work itself (L. de La Marche, pp. iv. *et seq.*). He studied at the University of Paris, and relates some interesting stories of student life (c. 360). He probably entered the order of St. Dominick at Lyons, where he became well acquainted with the Waldensian heresy. Like most of his order, he became a missionary, and preached the crusade against the Albigenses, as L. de la Marche says, probably at the time of the expedition of Louis VIII, in 1226. He was made an inquisitor by the Pope, and gives many curious anecdotes about his way of dealing with heretics. His long life, for he must have been nearly seventy at his death, was spent in the discharge of the busy duties of his office, which took him on frequent missions, some of which have left their traces in his work. One of the objects of the book, like those already mentioned, was to furnish preachers with *exempla*. These he does not give separately, and in alphabetical order, but incidentally in the course of a treatise on the seven gifts of the Holy Ghost (Isaiah xi. 2, 3): *Timor, Pietas, Scientia, Fortitudo, Consilium, Intellectus,* and *Sapientia*, whence the usual title *Liber de Septem Donis.** Each of the seven parts is divided into *tituli*, these again into chapters. Unfortunately, the learned author was overtaken by death in the midst of his fifth division (*Consilium*). In the prologue he conscientiously cites his authorities, and an interesting list it is, giving an excellent idea of the state of learning at that day. The editor notices the comparatively few classic authors cited; on the other hand, Etienne de Bourbon was perfectly acquainted with the whole range of mediæval theology, and borrowed freely from the *exempla* contained in the sermons of Jacques de Vitry. The editor roughly divides the *exempla* in Etienne de Bourbon into two classes: First, those taken from previous writers, historical works, sacred or profane, theological compilations, lives of the saints, legends, poetry, fables, etc.; secondly, those borrowed from events contemporaneous with the author, from his own recollection or that of his friends, and from traditions communicated to him by word of mouth. We shall follow, in the main, these divisions and mention first those stories which have no historical value, but are of importance for comparative storiology, indicating by means of his initials those which are borrowed from Jacques de Vitry.

First, fables and apologues: No. 43,† the son who bit off the nose of his father who had trained him up so badly that he ended his life on the gallows (Pauli, No. 19);‡ No. 225 (J. de V.), the traveler and the viper

* The MS. used by Lecoy de la Marche for his edition is that of the *Bibl. Nat.*, *fonds lat.* 15,970. The work is reproduced in a mutilated form in other MSS, mentioned by the editor, p. xxii. These contain generally mere *résumés* not extending further than the first division of the subject (*de dono Timoris*) hence the title applied to the work in the Catalan collection above mentioned.

† These numbers refer to the divisions introduced by the editor for convenience of reference, and which generally correspond each number to one *exempla*.

‡ In order to economize space, we refer where possible to the corresponding stories in Pauli, *Schimpf und Ernst*, Stuttgart, Litt. Ver., Bd. 85, and Kirchhof's *Wendunmuth*, same series, Bde. 95–99. These two works are edited by Hermann Oesterley, who has added the most exhaustive references to each story.

(Kirchhof 7, 73; Æsop ed. Furia CXXX; La Font. vi, 13); No. 271 (J. de V.), the milk-maid and the pot of milk (Kirchhof 1, 171; La Font. vii, 10; Max Müller, Chips, iv, 170; Joly, *Deux Fables*, etc., p. 91); No. 291, the mule boasting of his descent, "the horse is my grandfather" (cp. La Font. vi. 7; *Disciplina clericalis*, ed. Schmidt, p. 41; Pauli, No. 170; (Kirchhof 4, 138); No. 297 (J. de V.), the bat pretending to be a bird (La Font, ii. 5; Aesop ed. Furia, CXXV); No. 375, True and Untrue, the apes tear to pieces the one who tells them the truth (Pauli, No. 381; Phaedrus, app. 24; Robert, *Fables inéd.* ii, 547); No. 376, lion, wolf, and fox dividing prey; wolf takes better part, and lion tears off the skin of his head, the fox when asked who taught him to make a better division, replied, "He to whom you gave a red cowl" (Kirchhof 7, 24); No. 409 (J. de V.), the cobbler and the rich man (Kirchhof 2, 137; La. Font. viii. 2); No. 451 (J. de V.), the old man and his two mistresses, one pulls out his white hairs, the other, his black ones (Kirchhof 6, 67; Aesop ed. Furia, CXCIX).

The following list embraces all the legends and stories of general interest: No. 37, legend of the Knight in the Chapel (Köhler, *Jahrb. für rom. und eng. lit.*, vi, 326); No. 46, archdeacon who killed the bishop (*Miracles de Nostre Dame*, Paris, 1876, i, 101; cp. D'Ancona, *Sacre Rappresentazioni*, Florence, 1872, ii, 445); No. 81, the prince who bought for much money the advice: *In omnibus factis tuis considera antequam facias, ad quem finem inde venire valeas;* which maxim written on all the royal linen, etc., saves the king's life by terrifying the barber who had been bribed to kill him (cp. *Gesta Rom.* c. 103, for a more complete version, which is also found in several Italian popular tales: Gonzenbach, *Sicilienische Märchen*, 81; Gradi, *Pasqua di Ceppo*, p. 83); No. 130, a version of the Crescentia legend (D'Ancona, *Sacre Rappresentaz*, iii, 199); No. 143, the *fabliau De Brunain la vache au prestre* (Méon iii, 25; Luzel, *Légendes chrétiennes de la Basse-Bretagne* I, 30); No. 160, legitimate son recognized by refusing to shoot an arrow at the body of his dead father (*Gesta Rom.* 45; Wright's Latin Stories, No. 21); No. 161, a version of Bernier's *fabliau* of *La Housse partie* (Méon iv, 472; Von der Hagen, *Gesammtabenteuer* ii, p. lv, No. 48; Pauli, 436); No. 168, the legend of Robert the Devil (Græsse, *Literärgeschichte* ii, 2, 2, p. 628; Douhet. *Dictionnaire des Mystères, ad verb.*); No. 173, a version of the Alexis legend (*Gesta Rom.* 15); Nos. 176–178, the legend of Theophilus (D'Ancona. *op. cit.* ii, 445; Græsse, *op. cit.* ii, 2, 2, p. 625); Nos. 242–244 (J. de V.), examples of woman's obstinacy (Pauli 595; La Font. iii, 16; Dunlop's *Geschichte der Prosadichtungen uebertragen von* F. Liebrecht, Berlin, 1851, pp. 207, 274); No. 245, a long story of an old woman who makes mischief between husband and wife (Kirchhof 1, 366; Wright's Latin Stories, 100; *Promptuarium Exemp.*, M. 17); No. 246, dish of tongues good and bad (*Vita Aesopi*, Bromyard, *Summa praedicantium* L, 5, 5, Kirchhof 3, 129; a similar story is found in the Talmud, see Levi, *Parabole*, etc., Florence, 1861, p. 398, *La Lingua*); No. 248 (J. de V.), story of nun who tears out her eyes and sends them to

king who had fallen in love with her beauty (this story is taken from the *Vitae Patrum*, ed. Lugd. 1616, *lib.* x, *cap.* 60) ; No. 298 (J de V.), curiosity detected by putting a bird in a covered dish (Pauli, 398) ; No. 331, the famous apologue of the three rings employed by Lessing in his *Nathan der Weise* (*Gesta Rom.* 89) ; No. 338, Jew converted by seeing the Christian religion withstand the evil examples of its professors (Boccaccio, Dec. i, 1, see M. Landau, *Die Quellen des Decamerone*, Wien, 1869, pp. 65, 148) ; No. 339 (J. de V.), man carrying lamb to market is made to believe it a dog by three sharpers (for this famous Oriental story see Oesterley's references to *Gesta Rom.* 132. Pauli, 632) ; No. 370, the legend of the faithful hound (D'Ancona, *Il Libro dei Sette Savy di Roma*, Pisa, 1864, p.103, a Chinese Buddhist version is given by S. Beal in the Academy, Nov. 4, 1882 (No. 548), p. 331, "Bedd Gelert;" we shall revert to this story later) ; No. 373, Schiller's *Der Gang nach dem Eisenhammer* (*Gesta Rom.* 283); No. 396, Parnell's Hermit (*Gesta Rom.* No. 80, this legend has also become a popular tale: Gonzenbach, *op. cit.* No. 92 ; De Trueba, *Narraciones populares*, p. 65 ; Luzel, *op. cit.* i, 282, ii, 4) ; No. 414, treasure in trunk of tree (*Gesta Rom.* No. 109) ; No. 433 (J. de V.), story of innkeeper who used to tip over his customers' wine, saying: "*Hoc significat, abundanciam que veniet vobis, et bonam fortunam.*" A certain pilgrim to whom this had been done, privately opened the spigot of a cask, and repeated the above words to the angry host (Pauli, 372 ; *Novellette di San Benardino*, No. 29) ; No. 436 (J. de V.), a woman wishing to obtain access to a bishop in order to demand justice is told she must grease his hands (in the French sense *se faire graissir la main*), and follows the injunction literally (Pauli, 124) ; No. 460 (J. de V.), the famous story technically known as the Matron of Ephesus (D'Ancona, *Il libro dei sette savj di Roma*, p. 118, *Studi di Critica*, Bologna, 1880, p. 322 ; Griesebach, *Die treulose Wittwe*, Vienna, 1873) ; No. 494, the legend of the wood of the Cross (see A. Mussafia, *Sulla legenda del legno della Croce*, Vienna, 1869 ; W. Meyer, *Die Geschichte des Kreuzholzes vor Christus*, München, 1881) ; No. 502 (J. de V.), the stratagem employed by Sancho Panza while governor (Don Quixote, ii, 45) to discover whether a young man had done violence to a certain woman (Wright's Latin stories, No. 20) ; No. 507, a tradition of Homer who was forbidden to enter the king's palace while he wore a mean garb, but clothed in a rich dress was honorably received and obtained what he asked ; instead of thanking the king for the favor, he thanked his clothes (the story is told of Dante, Papanti, *Dante secondo la tradizione e i novellatori*, Livorno, 1873, p. 72. This story, too, has become a popular tale, and is related of the typical Sicilian booby, Giufà, see Gonzenbach, *op. cit.* i, 258).

Turning now to the class of popular superstitions, we shall find much that is interesting as illustrating the condition of society at that day. The belief in the divination of the cuckoo seems to have been widespread. A story is told of an old woman (No. 52), who heard on the first of May a cuckoo singing five times, and believed she would live at least that num-

ber of years more. On her dying bed she refused to confess, saying it was unnecessary as she should live five years, and when she grew too weak to speak she uttered the sound of the cuckoo five times, and finally held up her five fingers and died (Pauli, 289). In regard to unfavorable omens, Etienne de Bourbon cites a story from Jacques de Vitry about a king of Castile, who, while advancing against the Saracens, met a flock of crows. Some of the soldiers urged the king to return, but he very sensibly said that the crows were not older than four years, whereas he had fought more than twenty against the Saracens, and knew more about the way to fight them than the crows did. He advanced and beat his enemies (No. 353). In another story (No. 355), from the same source, an innkeeper detained a countryman in his tavern by making a noise with a bladder which the latter said was a bad omen. Fortune-tellers flourished then as now—one had a house divided into several parts, in one of which he received those coming to consult him, but overheard from an adjoining part what they said among themselves. The inquirers were then led by a roundabout way to that very part where the diviner addressed them by name, and answered their questions (No. 357). Another fortune-teller, an old woman, sent her son to steal the cattle of a rich peasant who lived at some distance, and tie them to a tree in the forest. The owner was then told by the son that in a certain town there was a good fortune-teller, who could inform him where his cattle were. This the old woman did, and earned great fame thereby (No. 358). The most interesting story of this kind, however, is one describing an event of which Etienne himself was an eye-witness (No. 360). We give it in his own words: "When I was a student in Paris, on Christmas Eve, while our companions were at Vespers, a certain notorious thief entered our lodging, and opening the room of one of our comrades, carried away several volumes of law books. When the owner wanted to use them after the holiday, he found they were gone, and hastened to the fortune-tellers (*malificos*). After many had deceived him, one conjured up some evil spirits and made the student look into a mirror, in which he saw, among other things, that a certain comrade of ours, a relative of his, and whom we believed the most honest of our number, had stolen his books. The owner accused him of the theft not only among the students, but also among his friends. When, however, the aforesaid thief had stolen some other things, and had been detected, he took refuge in the belfry of a church, and told every one who asked him, what he had stolen, and where it was. After some students who lived near us had discovered in this way a wallet (*mantica*), which had been stolen, the one who had lost his law books reluctantly consented to go to the thief, and inquire about them. The thief told him when and where he had stolen them, and designated the dwelling of the Jew to whom he had pawned them, and where the owner found them." Even the clairvoyants of the present day have their counterparts in the old women who had the dresses or girdles of the sick brought them, in order to divine the diseases of the owners (No. 363). Those were also the days of witchcraft (No. 364, 366, 367),

and the Wild Huntsman whose band was known as *familia Allequini vulgariter vel Arturi* (No. 365).* Many anecdotes of this kind came to the knowledge of Etienne while searching for heresy in the south of France. It is to his credit that he did not put much confidence in these absurd stories, although fortunately he deemed them worthy of preservation. We have already mentioned the story of the faithful hound, Bedd Gelert, which is of Oriental origin, and is found, for instance, in the Seven Wise Masters. After giving a version of this story, which has become in several places a local legend, Etienne proceeds to say that the dog was considered a martyr, and its grave was visited by the sick just like the shrines of wonder-working saints. Sick children especially were brought to the place, and made to pass nine times through an aperture formed in the trunks of two trees growing over the hound's grave, while various Pagan rites were performed, and the child was finally left naked at the foot of the tree until two candles an inch long were consumed. Etienne, by virtue of his office as inquisitor, had the dog exhumed, its bones burnt, and the grove cut down (No. 370). In this connection we may mention the dances which incur the writer's ire. He says the devil is the inventor, guide and advocate of the dancers (No. 461), and adds that there once appeared to a certain holy·man the devil in the shape of a little Ethiopian standing over the woman leading the dance, and guiding her about as he wished, and leaping over her head (*ibid*). Etienne derives the origin of dancing from the worship of Apis (*ibid*), and narrates several examples in which dancers were punished by the floor breaking through under them, and the church in which they were performing this incongruous act being struck by lightning (Nos. 462–63). These dances in the church, or rather, before it, and in the neighboring cemetery are frequently mentioned by our author. In Roussillon the feast of the patron saint was celebrated by the young people making and mounting a wooden horse, and dancing in the church and cemetery (No. 194). Sometimes the officiating priest was disturbed by these dances, and came out and broke them up very unceremoniously, as, for instance, a certain Master Stephanus de Cudo (Cudot), who, when he could not otherwise stop the throng, seized the *peplum* of the leader, a *majorissa* of the town, and pulled it off together with all her hair and the ornaments of her head (No. 275), a not unlikely proceeding as we shall see in a moment. Luxury in dress has always been a favorite subject of denunciation from the pulpit, and some of Etienne's stories prove that there is a greater permanence in fashion than we usually imagine. Blond hair seems to have been as popular in the XIII as in the XIX century, and the length of ladies' trains seemed then an invention of the devil. We have just seen how a priest put an end to a dance by pulling off the leader's mantilla, and with it her false

* A counterpart to this myth is that of the *bonnes choses*, or *bonesozes* (see L de la Marche's note to No. 97), women who supposed that they accompanied at night Diana or Herodias mounted on certain beasts and traversed wide spaces of the earth and air.

hair—an incident that occurs more than once in Etienne's pages. One Palm Sunday, while the procession was passing the window of a wealthy clerk, a pet monkey descended by its chain, and snatched off the wig of an old woman, and then climbed back displaying his trophy in great glee, Etienne happening to be in the procession when this occurred (No. 274).* Painting the face was likewise common and liable also to shameful detection, as where a mountebank filled his mouth with water and blew it into the painted face of a woman with a result that can easily be imagined (No. 279). A more delicate trick was that of a magnate who made a hole in a cushion, and blew the feathers in the face of a lady sitting near him; when she discovered the feathers sticking to her face she tried to rub them off, but only made matters worse, until at last she looked like an image that had undergone repairs, "*ad modum imaginis reparate*" (No. 280). The pointed shoes of this period, as well as the women's long trains, were favorite resorts of the devil. A woman who had been dancing for some time could not move her feet for several days, at last they cut off the points of her shoes, and out came the devil with a noise, and the woman recovered (No. 281). Etienne repeats (No. 282) a story of J. de Vitry's, who says a certain holy man once saw the devil laughing, and asked him the reason. He was told that one of the devil's companions was accustomed to ride about on a lady's train, and when she lifted her dress at a muddy spot the devil fell off into the mire.† The costliness and weight of women's girdles or belts also called for reproof. They were made of iron, silk, silver or gold, and adorned with precious stones; some were ornamented with the figures of lions and dragons, and birds wrought in gold and silver, the workmanship of which was more costly than the material. They were so heavy that the wearers would refuse to carry in penance about their waists an equal weight in lead or iron.‡

Our space will not permit us to examine at equal length the class of historical anecdotes or those related by Etienne as an eye-witness. A very complete and vivid picture of society might be drawn from this work: the schools, the streets of Paris, the open-air preaching, the crusade against the Albigenses, Saint Louis and his crusade, in short, the civil, ecclesiastical, and military life of the day are unrolled before us, while the theologian or church historian will find valuable materials in Etienne's detailed account of the heresies of that time (pp. 290–314).

* Bourgain, *La Chaire française*, p. 12, n. 4, cites the following passage from Hugues de Saint-Victor, which will illustrate the above *exemplum*: "(Simiam) que licet villissimum et turpissimum et horrendum sit animal, tamen heu! maxime clerici in suis domibus hanc habere et in suis fenestris ponere solent, ut, apud stultos qui pertranseunt, per ejus aspectum gloriam suarum divitiarum jactitent."

† Cæsar of Heisterbach, *Dial. Mirac.* v. 7, says that an honest citizen of Mainz saw a multitude of devils on the train of a lady of that city. "They were small as mice, black as Ethiopians, laughing and clapping their hands and jumping about like fish in a net."

‡ For further details of this kind see L. de la Marche, *La Chaire française*, pp. 404, 412.

The second work of the class of treatises which we shall notice is the *Summa Virtutum ac Vitiorum* of Gulielmus Peraldus, also a Dominican and bishop of Lyons.* He died in 1275, leaving besides the above work a large number of sermons. The *Summa*, which is quoted by both Herolt and Etienne de Bourbon, is, as its name indicates, a treatise on the principal virtues and vices, forty of the former and forty-one of the latter being considered in detail. For convenience of reference the work is supplied with very full indices and analytical tables of contents. The *exempla* no longer have the importance attributed to them in the works we have already cited, and when they are used for purposes of illustration, they are given in a dry, brief way. For example, under the head of *Invidia* (Vol ii, p. 281), Peraldus cites a well-known story as follows: "Exemplum de quodam rege, qui concessit cuidam avaro et cuidam invido munus quod eligerent, ita tamen quod munus ejus qui posterior peteret, duplicaretur: et cum uterque differet, præcepit rex invido ut prius peteret: qui petit ut eruetur sibi unus oculus, volens quod proximo eruerentur ambo." † Although Peraldus's work possesses but little of the interest of the work last discussed, it is still valuable. The writer was a learned man, and cites not merely the Christian authors popular during the middle ages, but quotes constantly from the classics, From his pages may also be gleaned many details of mediæval society.‡

The most extensive and in many respects the most valuable of all the works of the class we are now examining is the *Summa Praedicantium* of John Bromyard, an English Dominican.§ He was from Herford, and became a celebrated theologian and jurist at Oxford. He was afterwards professor of theology at Cambridge, and is said to have been one of Wicliff 's opponents in the Council of London, 1382. He died in 1418,

* The first edition is Cologne, 1479. It has been frequently reprinted since; our copy is Cologne, 1629, two volumes, 4to.

† As this story, which is of Oriental origin (see Benfey, Pantschatantra, i, 498, 804), is found in three of the collections we are examining, we have an opportunity to compare its treatment by the various compilers. Herolt, *Prompt, Ex.* I, 33, is almost as concise; Bromyard, I, 6, 19, is a little more diffuse; Holkot, *Super Sapientiam, lect. XXIX*, gives the story as follows: "Narratur de quodam cupido et invido insimul iter agentibus quod vox de cœlo venit ad eos dicens: Petat unus quidquid voluerit et habuerit, sic tamen quod socius ejus habebit duplum. Fit contraversia quis eorum prius peteret. Tandem invidus: Peto, inquit, ut eruatur mihi alter oculus." This story was always a very popular one, as may be seen by a glance at the long list of parallels cited by Oesterley to Pauli, 647. Another story in Peraldus ii, 307, "true son refusing to shoot arrow at father's dead body," may likewise be compared with Etienne de Bourbon, No. 160 (mentioned above), Bromyard, F. 5, 17, *Prompt. Ex.*, B. 9, and *Libro de Enxemplos*, 103 (see also *Gesta Rom.* ed. Oesterly, cap. 45).

‡ Peraldus, too, reproves trains and long shoes ii, 211, 212, 215.

§ This work, although popular, has not passed through as many editions as some of the above mentioned work. The following are all the editions we can discover: *editio princ.* s. l. e. a. fol.; Norinberg., 1485, 4to. (Fabricius, fol.); *ibid.*, 1518, 4to.; Parisiis, 1518, 4to.; Lugd., 15, 22, 4to; Venet. 1586, fol. (Fabr. 4to); Antverp, 1614, fol. Our copy is the last named.

leaving, besides his *Summa* and some writings against Wicliff, a work entitled: *Opus trivium sive tractatus juris civilis et canonici ad moralem sensum applicati secundum ordinem alphabeti.** Some idea of the extent of the *Summa* may be gained from the fact that the edition of 1614 consists of two parts containing nine hundred and seventy-one folio pages, exclusive of the indices. The arrangement is the usual one of topics alphabetically disposed: nineteen letters (or twenty-one, distinguishing i and u) embracing one hundred and eighty-nine topics treated in as many chapters. The range of subjects may be shown by the titles under some of the letters taken at random. We give all the divisions of the letters chosen, naturally, however, selecting those which contain fewest chapters: *Beatudo, bellum, benefacere, bonitas; gaudium, gloria, gratia, gratitudo, gula; labor, laus, lex, liber, loquatio, ludus, luxuria; nativitas, negligentia, nobilitas, nocumentum; tentatio, testimonium, timor, trinitas, tribulatio,* etc. Each chapter is preceded by a *summarium* of the sections into which it is divided, and these sections are still further divided into paragraphs or articles. The *exempla* are usually, but not always, indicated by the word *exemplum* or its abbreviation in the margin. The stories themselves are, as in Peraldus, generally given in brief and dry versions. These illustrative *exempla,* which, for us, constitute the chief value of the work, are very numerous. Goedeke (*Orient und Occident,* i, 538) says their number is over a thousand, and remarks: "Kaum irgend ein anderes Werk des Mittelalters ist so reich an Fabeln und Geschichten als das seinige (the *Summa*), und kaum ein anderes von dieser Bedeutung so wenig bekannt. Wright (Latin Stories, Percy Soc., Vol. viii, p. viii) says: "Perhaps no work is more worthy the attention of those who are interested in the popular literature and history of England in the fourteenth century."† Bromyard seldom names his sources, but as Goedeke (*op. cit.,* p. 538) says: "Ueberall darf Entlehnung vorausgesetzt werden." These sources are the whole body of mediæval and classical literature then known to the learned. Scarcely any department of these two great divisions is unrepresented: fables, legends, mediæval epics, Oriental apologues, anecdotes from Roman history, from Biblical history, popular jests, etc., are mingled with a mass of references to contemporary manners and customs which render the work invaluable to the student of mediæval culture. It is impossible in our limited space to give even a brief selection from Bromyard's stories. Those cited by Wright will give those who do not have access to the original a fair idea of its contents, and a glance through Oesterley's references to Pauli, Kirchhof, and the *Gesta Romanorum,* will show that Bromyard has absorbed into his vast encyclopedia most of the popular stories of his day.‡

Before leaving the class of treatises, there is one work which may be

* Fabricius, *ed. cit.,* i, p. 263; Græsse, ii, 2, 1, pp, 166, 380.

† Of the one hundred and forty-nine stories given by Wright, over fifty are taken from Bromyard, and eleven from the *Promptuarium Exemplorum.*

‡ About one hundred and fifty of Bromyard's stories are found in these collections.

mentioned here, although, strictly speaking, it is not a treatise in the same sense as the works already described. We refer to Robert Holcot's *Opus super Sapientiam Solomonis.** The author was, like Bromyard, an English Dominican, born at Northampton, and professor of theology at Oxford, where he died in 1349, leaving a large number of commentaries on various books of the Bible, the best known being, the one on the Wisdom of Solomon.† This work consists of two hundred and twelve *lectiones* on the nineteen chapters of the wisdom with the usual extensive index. *Exempla* properly so-called are very sparingly used by the author, one of them (Pauli, 647), has already been given above, and one of La Fontaine's most celebrated fables (Bk. vi, 4, "Jupiter et le Métayer") is found in *Lectio* IX. On the other hand, the work is a vast repertory of historical anecdotes embedded in the most elaborate metaphors. A good example of Holkot's method may be found in the *Lectio* LXIV, where he discusses Chap. V, v. 9–10 of his text, "All those things are passed away like a shadow, and as a post that hasteth by ; And as a ship that passeth over the waves of the water, which, when it is gone by, the trace thereof cannot be found, neither the pathway of the keel in the waves." As there are three kinds of sin : original, venial, and mortal, so there are three kinds of shadows corresponding in shape to the cylinder, cone, and inverted cone (*chilindroydes*, *conoydes*, and *calathoydes*). In speaking of the simile of the ship, Holkot quotes from St. Jerome's *epistolae*, cxv, the story of Xerxes weeping because none of those he beheld at a review of his army would be alive in a hundred years. He then compares penitence to a ship on account of its figure, capacity for carrying, and possibility of wreck. This affords Holkot an opportunity, after citing Job, Boethius, and Gregory, to describe the Sirens and Ulysses's adventure with them. His sources are, as he states : *Alexander in scintillario poesis,*‡ and Boethius, *de Consolat*, iii. 8. In his third lecture he

*See Hain, Nos. 8755–61. The first edition is of Cologne, no date, our copy is the third edition (Hain, No. 8757); Spires, 1483, Petrus Drach. For other editions, see Graesse, *op. cit.* ii, 2, 1, p. 470.

†Holcot left another work which would also come within the scope of this article, but which we have not been able to procure. It is the *Moralitates pulchrae historiarum in usum praedicatorum*, Venet. 1505; Paris, 1510, and with the *Liber Sap.*, 1580. This work varies somewhat in the different editions, but the original form seems to have consisted of forty-seven stories, afterwards amplified to seventy-five. This collection is of great importance for the question of the mode in which the *Gesta Romanorum* was put together, and Oesterley in his edition of that work, after an analysis of the *Moralitates*, says, p. 251: "Die Wichtigkeit dieses Werkes braucht nicht besonders hervorgehoben zu werden, es ist in ihm nicht allein die Quelle vieler Nummern des Gesta Romanorum nachgewiesen, die bisher unbekannt geblieben war, sondern dasselbe hat auf die Gestaltung unserer Sammlung einen so entscheidenden Einfluss ausgeübt, dass man die sämmtlichen Handschriften in zwei Classen theilen könnte, deren eine von Holkot beeinflusst ist, deren andere aber einen solchen Einfluss nicht zeigt, und es ist das ein nicht unwichtiges Moment für die Entscheidung der Frage über das Alter der Gesta Romanorum."

‡This is Alexander Neckam, see Leyser, *Hist. Poetarum et Poematum Medii Aevi*, Halle. 1721, p. 993.

mentions Alexander and the pirate (*Gesta Rom.* 146); in the ninth occurs the fable of La Fontaine vi, 4, mentioned above; in the fourteenth, the story of Atalanta (*Gesta Rom.* 60), cited from Ovid; in the forty-fifth, the story of the two snakes (*Gesta Rom.* 92), cited from Valerius Maximus (4. 6, 1); in the seventieth, Damocles's sword cited from Macrobius, *Somn. Scip.* 1, 10 (*Gesta Rom,* 143); in the eighty-second, the poisoned wine from Frontinus, *Strateg.* 2. 5, 12 (*Gesta Rom.* 88); in the eighty-sixth "judge flayed," from Helinand, lib. xv. (*Gesta Rom.* 29); in the one hundred and thirteenth, "the ring of forgetfulness and memory," from "*magister in historiis super Exodus,*" the story is told of Moses (*Gesta Rom.* 10, of the Emperor Vespasian); in the hundred and forty-first, the story of Phalaris and his brazen bull from Ovid (*Gesta Rom.* 48); in the one hundred and seventy-fifth, Coriolanus, Valerius Maximus 5, 4, 1 (*Gesta Rom.* 137); in the one hundred and eighty-eighth, La Fontaine, vii, 1, *Les Animaux malades de la peste;* in the hundred and ninetieth, the legend of Silvester II (Gerbert), v, Milman Latin Christ, iii, p. 220; *ibid,* wax image of husband shot at by wife's lover (*Gesta Rom.* 102). We have mentioned only a few of the stories most popular during the middle ages, and our citations can give but a feeble idea of the mass of historical and mythological references to be found in Holkot.

It remains finally to notice very briefly the class of sermons from which we have selected two of the most popular collections as examples.* The first is the sermons of Herolt who has already been considered as the author of the *Promptuarium Exemplorum.* The popularity of his collection was shown by the large number of editions through which it passed, and all we have now to do is to examine the form and contents of the work itself.† The sermons, as is usual, are divided into those for the ordinary Sundays of the year, *de tempore,* and those for saints' days, *de sanctis*; of the former there are one hundred and sixty-four, of the latter forty-eight. From one to five sermons are devoted to a single Sunday or saint, and reference is sometimes made to other sermons in the same collection which may likewise be used. Where several sermons are given for one occasion, they are considered as one, and the method of division is continuous. This consists in a rude paragraphing by means of capital letters. Not only is reference facilitated by an alphabetical index, but an additional index is given of the *exempla* in the *sermones de tempore* and a briefer index of the *sermones de sanctis.* As to the organic division of the sermons, the

* For the vast mass of inedited material, see L. de la Marche, *La Chaire française,* etc., *table bibliographique,* pp. 457–499; for printed sermons, Græsse, *op. cit.* ii, 2, 1, pp. 152–175; for collections of sermons designed especially for the use of preachers, Cruel, *op. cit.* pp. 468–493; for general *résumé* (XIV century), *Hist. litt. de la France,* xxiv, pp. 363–382.

† Cruel, p. 480, says: "The most used work of this class (the sermons for the use of preachers) are the *Sermones Discipuli,* which passed through thirty-six editions before 1500. How well known this work was is shown from a passage in Geiler's Postils to the eighth Sunday after Trinity, where the author after the division of his subject into heads, says: Now mark! you will find these things neither in Jacobo de Voragine nor in Discipulo."

author in the prologue to the *serm. de sanctis*, says: "Dividendo eundem sermonem in tres partes. Pria pars erit de dignitate et privilegiis istius sancti vel istorum sanctorum et sanctarum. Secunda pars principalis erit pro informatione hominum simplicium et specialiter ad emendationem suae vitae. Tercia pars erit de miraculis istius sancti aut illorum sanctorum vel sanctarum." The division of the *sermo de tempore* is also usually threefold, the *exemplum* coming last. The following brief analysis of one of Herolt's sermons may not be unacceptable. *Sermo xvi, De innocentibus.* "Mittens Herodes occidit omnes pueros qui erant in Bethleem et in omnibus finibus ejus, Matt. ii. Ex quo hodie peragitur festum illorum puerorum innocentium qui ab iniquo Herode interfecti sint, tunc in presenti sermone tria sunt dicenda. Primo quod aliqui parentes suos pueros spiritualiter occidunt sicut Herodes corporaliter occidet. Secundo de solemnitate presentis festi. Tercio exemplum." "There are six classes of parents who kill their children: those who kill the child yet unborn, those who love their children too much ("Qui amat filium vel filiam super me non est me dignus," Matt. x), those who teach them evil, as dancing, wearing their rich clothes, painting their faces and curling their hair, those who do not punish their children when they err, those who set their children a bad example, and thus kill them spiritually, and finally those who amass wealth unjustly in order to enrich their offspring. Secondly, the feast of the Innocents is to be observed solemnly for three reasons: first, on account of the time, they were the first martyrs, secondly, on account of their number, thirdly, on account of the place. Thirdly, mark an example of those who do not correct their children when they err. We read of a certain father who was accustomed to visit taverns and games, and take his little son with him. When the son grew up he was so used to taverns and games that he could not be kept away from them, and after he had spent his own money, he began to steal, first from his father, then from his neighbors. His father did not punish him severely, but gently reproved him. This admonition, however, had no effect, and when he grew to be a man, he was caught once and again in theft, but twice was saved from the gallows by a fine. The third time he was detected he was sentenced to death, and led to the gibbet. There he begged that his father might be brought to him. He came weeping, and the son asked him to kiss him, and forgive him the wrong he had done him. When the father did as he was asked, his son bit off his nose. The son was censured because twice his father had saved him from death by paying a fine, and would gladly have freed him a third time had he been able. The son, however, answered: 'I have acted well and justly because he is the cause of my death, for from my youth up he permitted me to live according to my own will, neither corrected me at any time for the excesses I committed.'"* At the end of the lxxxiv, sermon *de tempore* (*De gaudiis coeli*) occurs the following beautiful and well-known *exemplum* which Mr. Longfellow's readers will recognize as the story of Monk Felix in the Golden Legend.

* For parallels see Pauli, 19. This story occurs in Etienne de Bourbon, and has been already mentioned.

"Likewise we read this example of the joys of Heaven. A certain devout monk prayed God to reveal to him some of the sweetness of the heavenly joys. One day while at prayer he heard a little bird singing sweetly near by. Arising from his prayers he wished to catch the bird which flew away before him to a wood near the monastery, and alighted on a tree. The monk followed it and stood under the tree listening to the bird which presently flew away, and the monk returned to the monastery thinking he had stood beneath the tree an hour or two. When he reached the monastery he found the door had been built up, and another opened in a different part of the monastery. He approached and knocked, and the porter asked whence he came, who he was, and what he wanted. He replied: I left the monastery a little while ago, and now I have returned, and it has been changed. The porter went in and told the abbot, who came to the door and asked the monk who he was and whence he came. He responded: I am a brother of this monastery, and I went a short time ago to the wood, and returned, and I know no one, and no one knows me. Then the abbot and the seniors asked him the name of the abbot who ruled the monastery when he went out, and searching the chronicles they found he had been absent from the monastery three hundred and forty years. It was a great thing that in all that time on account of the sweet song of that bird or angel, he had felt neither cold nor heat, neither had hungered nor thirsted. What then shall it be when we enter heaven and hear the nine choirs of angels singing?"* In concluding this very inadequate account of Herolt's collection, we cannot do better than cite a few words from Cruel's appreciation (p. 481): "The work was very copious, and exerted from the large number of its *exempla*, a peculiar attraction. What, however, above all, made it popular and distinguished it from earlier collections was the practical direction of its contents, whereby the author held himself free from all doctrinary generalities, and kept in sight the concrete truth in order to bring before the bar the prevailing faults and vices of his day, and to examine from an ecclesiastical standpoint the most various relations of civil life. The editors of the earliest edition (1476) had this especially in view, when they remarked in their concluding words: 'Huic (autori) applaudi, hunc efferri laudibus, hunc praedicatum iri miretur nemo, cum certissime constet, inter modernos sermonistas eum in vulgi scientia tenere principatum.' In order to become acquainted with this practical popular side one needs only to glance over a list of the subjects he treated. Superiors and dependents, masters and servants, manufac-

*See Von der Hagen's *Gesammtabent*, xc: *Magnum Spec. Exemp.*, *Coelestis gloria*, *Exemp. xiv*; cp. Ralston's Russian Folk Tales, p. 310; Cox, Aryan. Myth. i, 413; Baring Gould's Curious Myths, 1872, pp. 92, 112. The following are some of the most popular *exempla* in the sermons; as this work must be rare in this country, we mention where corresponding stories may be found in more accessible collections: *Gesta Rom.* 80, 125, 143, 171, 215, 249; Pauli, 19, 84, 222, 388, 398, 462; Kirchhof 1, 366; 1, 2, 50; La Fontaine vi, 4; Etienne de Bourbon, 43, 258, 298. In the xxi *Sermo de sanctis* may be found an interesting version of the legends of the wood of the cross, see Meyer, *op. cit.* p. 28.

turers and workmen, nobility, merchants, Jews, usurers, dancing, oaths, blasphemy and profanity, jesting and play, falsehood, sinful apparel, superstitions, duties of parents to children, and *vice versa*, how one can sin in eating, etc."

The last collection we shall mention is that of Oswald Pelbart, usually called Pelbartus de Themeswar, a Franciscan monk from Themeswar in Hungary, who flourished in the latter part of the fifteenth century, and was widely known by his sermons. The collection bears the fantastic title of *Pomerium* (orchard), and consists of *sermones de tempore, de sanctis*, and *quadragesimales*.* Another work by the same author is usually bound up with one of the above collections. It bears the somewhat misleading title: *Pomerium sermonum de beata virgine dei genetrice vel Stellarium corone beate virginis pro singularum festivitatum eiusdem predicationibus compilatum*. It is not, as might seem, a collection of sermons, but a treatise in twelve books for the use of preachers, and might perhaps more properly have been mentioned above. The last part of the twelfth book is devoted to the miracles of the Virgin. The *sermones de sanctis* number in all two hundred and twenty-one; ninety-seven in the *pars hyemalis*, and one hundred and twenty-four in the *pars estivalis*. As in Herolt, so here several sermons are devoted to the same feast, the first of the series containing the legend at the end of the sermon. The sermons are paragraphed in the usual way, and there are copious indices. The work no longer has an anecdotal character, a strict analytical method is pursued, and the writer generally confines his citations to the Scriptures, and the doctors of the Church.

We shall take leave of the last class of our subject with a brief reference to some sermons in the vulgar tongue containing *exempla*. They are the sermons of St. Bernardino of Siena, who died in 1444, and was canonized six years later. Thus far only ten of the forty-five Italian sermons of St. Bernardino have been edited (Siena, 1853), the *exempla*, however, to the number of thirty-eight have been extracted, and published by Francesco Zambrini, under the title: *Novellette, esempi morali e apologhi di San Bernardino da Siena*, Bologna, 1868 (*Scelta di curiosità letterarie inedite o rare dal secolo xiii al xvii. Dispensa xcvii*). Many of these *exempla* are contemporaneous anecdotes, here and there are found fables or stories forming part of the common stock of Europe. Among the fables are: iii. La Fontaine iii. 1; vi. *ibid.* xi. 6; ix. Voigt. *Kleinere latein. Denkmäler der Thiersage*, Strassburg, 1878, pp. 81, 138; *xvii.* "*Di una scimia la quale per vendetta arse uno orzo;*" *xxx.* "*Dell' asino delle tre ville,*" for the last two we have found no parallels. Among the stories are: xiv (Etienne de Bourbon, 456); viii (*ibid.* 385); xxix (*ibid.* 483, Pauli, 372).†

* For editions see Hain, Nos. 12544–48; Graesse ii. 2. 1. p. 430; Fabricius, ed. cit., v. 233. We have been able to procure the *sermones de sanctis* only in the edition of Hagenau, 1511, fol. containing also the *Stellarium corone B. V.* mentioned above.

† While this article was in preparation, our eye fell on the following advertisement, which again proves that there is nothing new under the sun: "——— & Co.

We have performed our task in a very bungling manner if we have not enabled the reader to form some idea of the wealth of material buried in these long unused volumes, material of great value for the historian of manners and customs, and for one engaged in tracing the affiliation of the popular tales of Europe. As it is in the latter direction that our own interest chiefly lies, we may be pardoned for concluding this already lengthy article with some reference to the light thrown upon the diffusion of popular tales by the collections just examined. In these we find every class of popular tales except fairy stories—legends, jests, fables, etc. The extensive currency given to these stories by their reception into these collections can hardly be imagined. They were used by numberless preachers in their sermons to the people, and by them in turn repeated to others. We must bear in mind that down to the Reformation Europe constituted a homogeneous whole, and that there existed a *Weltliteratur* in Goethe's sense of the word. A legend or story that appealed to the imagination or taste had free circulation from Iceland to Sicily, and from Italy to Portugal. One or two examples will perhaps best illustrate the part played by the sermon-books in this diffusion. We have already mentioned La Fontaine's fable (vii, 10), *La Laitière et le pot au lait*. and have shown that before the version in the *Dialogus Creaturarum*, the fable was widely diffused by Jacques de Vitry and Etienne de Bourbon. A still more striking instance of another Oriental apologue introduced into Europe by the same channel is the fable which Gœdeke entitles *Asinus vulgi* (La Font. iii, 1' *Le Meunier, son Fils et l'Ane*), first found in an Occidental version in Jacques de Vitry, and copied from him by Etienne de Bourbon.* The former of the two stories just mentioned has become popular in the technical sense, and is found in Grimm's *Kinder-und Hausmärchen*, No. 164, *Der faule Heinz*, but in a version pointing to the Oriental original in the Pantschatantra and Hitopadesa. It would, however, not be difficult to find stories still existing among the people, and which were originally communicated to them by the sermon-books. An interesting instance of this is the story found in Grimm No. 145. The ungrateful son (*Der Undankbare Sohn*), which is so short that we may give it in full: "Once upon a time a man and his wife were sitting before their house-door, with a roast fowl on a table between them, which they were going to eat together. Presently the man saw his old father coming, and he quickly snatched up the fowl and concealed it, because he grudged sharing it, even with his own parent. The old man came, had a draught of water, and then went away again. As soon as he was gone, his son went to fetch the roast fowl again ; but

will begin publication immediately of 'The Clerical Library,' or helps to sermonizing as the series might be called. Three of the proposed twelve volumes, each of which will be complete, are entitled, 'Three Hundred Outlines of Sermons on the N. T.,' and again on the O. T., and 'Outline Sermons to Children with Numerous Anecdotes.'"

*See Gœdeke's article already mentioned in *Orient und Occident*, i, pp. 531, 733; Pauli, 577, to the references given in these articles may be added, San Bernardino, *Novellette*, p. 5.

when he touched it he saw that it was changed into a toad, which sprang upon his face and squatted there, and would not go away. When any one tried to take it off, it spat out poison and seemed about to spring in the face, so that at length nobody dared to meddle with it. Now this toad the ungrateful son was compelled to feed, lest it should feed on his flesh ; and with this companion he moved wearily about from place to place, and had no rest anywhere in this world." This very story is found in Etienne de Bourbon, 163, Bromyard, F. 22, Pelbartus, *Serm. de Temp. Hiem.*, 22, B, not to mention other works of the same class, which are mentioned in Oesterley's notes to Pauli, 437, and in Douhet, *Dictionnaire des Légendes*, col. 305, n. 158. Until quite recently Grimm's version was the only popular one known, but a version from Lower Brittany has lately been published by F. M. Luzel, *Légendes chrétiennes de la Basse-Bretagne*, Paris, 1881, vol. ii, p. 179, *Le Fils ingrat.* There are probably other popular versions which have not yet been collected, the class of legends or legendary and religious stories having been greatly neglected by collectors of popular literature. There is no need of insisting upon the importance of the *exempla* in the diffusion of stories, but we may mention in conclusion two cases of wholesale absorption of Oriental stories into collections of *exempla* or similar works. The first case is that of the *Disciplina clericalis* of Petrus Alfonsi, which has been taken up into the *Libro de Enxemplos* mentioned above ; the second is the Seven Wise Masters, a compend of which is found in the *Scala Coeli* of a Dominican monk, Joannes Junior, who lived in the middle of the XIV century, and wrote a work of the same general description as Bromyard's and Etienne de Bourbon's.* Separate stories from both of the above Oriental collections are frequently encountered among the popular tales of Europe, and their wide diffusion is doubtless due to their absorption into the above collections.

The Latitude of Haverford College Observatory. By Isaac Sharpless.

(Read before the American Philosophical Society, April 6, 1883.)

The latitude of Harverford College Observatory was determined in the year 1854, by Prof. Jos. G. Harlan, by the use of a transit instrument in the prime vertical. Imperfect records of his results and none at all of his computations remain, but from them he deduced a value of $40^\circ\ 0'\ 36.5''$.

In the spring of 1881, a zenith instrument was placed in position in the observatory. The telescope has an aperture of $1\frac{3}{4}$ inches, and with its standards revolves about a vertical axis. It is provided with micrometer and levels.

* This compend of Joannes Junior is of great importance in the study of the Western branch of the Seven Wise Masters, and has been reprinted by K. Goedeke in the *Orient und Occident*, iii, pp. 388–423, *Liber de septem Sapientibus*.

The latitude was determined by pairs ot stars, one of each pair being north and one south of the zenith. The difference of the zenith distances was measured by the micrometer and the latitude calculated by the formula,

$$\varphi = \tfrac{1}{2}(\delta + \delta') + \tfrac{1}{2}(Z - Z')$$

As a preliminary work the value of a revolution of the micrometer screw was determined by observing the passage of a star between the wires set at some known distance apart, and multiplying the time by the factor $\frac{15 \times \cos \text{Dec}}{\text{Dist. between wires}}$. The mean of twenty-one observations was 111.6″.

A better result was obtained by the method of observing Polaris at time of greatest elongation. This time T_0 and the zenith distance Z_0 were first calculated and the telescope set at the latter angle. About twenty minutes before T_0 the movable micrometer wire was set in front of the star and the time of crossing recorded on the chronograph; the wire was then advanced one-fifth of a revolution, and the time again noted, and so on forty times. From these were obtained twenty values of a revolution of the screw. The computation is given in outline in the following table. The quantity $Z - Z_0$ was computed in each case by the equation:

$$Z - Z_0 = \sin (T - T_0) \frac{\cos \delta}{\sin 1''}$$

The level error was so slight that it was not taken into account;

No.	Micrometer Reading.	T.			T—T₀.			Z.—Z₀.
1	6.80	$6^h\ 50^m$	18.ˢ2	—	21^m	3.ˢ1	—	433.59
2	6.60	51	16.2	—	20	5.1	—	412.68
3	6.40	52	33.2	—	18	49.1	—	387.70
4	6.20	53	34.2	—	17	47.1	—	366.55
5	6.	54	40.9	—	16	40.4	—	343.59
	etc.	etc.			etc.			etc.
21	2.80	6^h 72	0.2	+	0	38.9	+	13.55
22	2.60	73	16.4	+	1	45.1	+	36.12
23	2.40	74	17.4	+	2	56.1	+	60.52
24	2.20	75	4.2	+	3	42.9	+	76.61
25	2.	76	14.4	+	4	53.1	+	100.74
	etc.	etc.			etc.			etc.

Comparing the 1st observation with 21st, the 2d with 22d and so on, and dividing the results by 4, we obtain for the value of a revolution of the screw by this method the following:

111.78	111.25	113.04	109.92
112.20	110.71	113.98	112.66
112.05	111.28	113.26	112.76
110.76	110.67	112.78	111.88
111.08	111.59	112.25	111.16

The mean of these is 111.″9 and this is the value employed in subse-

quent work. The probable error of this mean by the method of least square is 0.″14.

The value of a level division was obtained by placing the movable micrometer wire on a terrestrial mark, and taking the reading, and again after the instrument was changed in altitude so as to cause the bubble to to move through a certain number of divisions. This gave it in micrometer revolutions, which were afterwards reduced to seconds. The result of a large number of determinations gave, as the most probable value, 6″.8.

The stars used were taken from the Nine Years Catalogue of Greenwich Observatory for 1872, the mean declinations calculated for the epoch 1881.0, 1882.0, or 1883.0, and the apparent declinations for the night of observation were obtained by the use of the "independent star numbers" of the American Nautical Almanac. The results were as follows:

Date.	Catalogue No. of Stars.	$\frac{1}{2}(\delta + \delta')$	Micrometer Correction.	Level Correction.	Latitude.
1881.					
10 mo. 26.	62 77	40° 5′ 32″.99	— 4′ 45″.85	— 6″.72	40° 0′ 40″.42
"	2166 2185	40 0 56.29	— 16.45	+ 8.	42.84
"	48 51	39 56 22.	+ 4 6.23	+ 10.5	38.78
10 mo. 27.	48 51	39 56 22.	+ 4 25.65	— 8.1	39.55
11 mo. 15.	2166 2185				42.92
"	48 51	39 56 24.45	+ 4 19.83	— 4.5	40.08
12 mo. 8.	48 51	39 56 26.23	+ 3 57.26	+ 17.85	41.34
12 mo. 9.	48 51	39 56 26.29	+ 3 57.57	+ 20.1	43.89
12 mo. 10.	48 51	39 56 26.30	+ 4 1.59	+ 14.6	42.49
"	62 77	40 5 41.87	— 5 13.27	+ 14.6	43.20
12 mo. 16.	48 14	39 56 26.39	+ 4 30.50	— 11.85	45.11
"	62 77	40 5 38.40	— 4 43.65	— 14.7	40.05
12 mo. 17.	62 77	40 5 38.46	— 4 50.65	— 7.7	40.11
12 mo. 19.	48 51	39 56 26.54	+ 4 24.07	— 12.8	38.31
"	62 77	40 5 38.48	— 4 50.16	— 9.9	38.42
12 mo. 24.	48 51	39 56 26.80	+ 4 16.86	— 2.4	41.26
"	62 77	40 5 38.48	— 4 51.5	— 8.55	38.28
1882.					
1 mo. 27.	567 569	40 6 16.17	— 5 42.02	+ 5.78	39.93
1 mo. 30.	530 550	39 59 51.73	+ 42.69	+ 3.	37.42
"	567 569	40 6 24.03	— 5 39.50	+ 6.13	38.40
2 mo. 1.	530 550	39 59 51.44	+ 41.24	+ 6.45	39.13
"	567 569	40 6 15.67	— 5 43.53	+ 3.80	35.94
2 mo. 8.	530 550	39 59 58.19	+ 32.12	+ 12.6	42 91
2 mo. 10.	530 550	39 59 58.27	+ 30.21	+ 9.88	38.36
"	567 569	40 6 22.28	— 5 46.38	+ 8.8	39.20
2 mo. 11.	530 550	39 59 58.81	+ 37.88	+ 8.85	45.04
2 mo. 14.	567 569	40 6 22.00	— 5 48.34	+ 2.55	36.21
2 mo. 17.	530 550	39 59 58.60	+ 28.98	+ 8.85	36.43
11 mo. 5.	2049 2070	40 0 59.76	+ 6.32	— 22.05	44.08
11 mo. 9.	2049 2070	40 0 59.645	+ 1.119	— 20.217	40.55
12 mo. 8.	2166 2185	40 1 15.578	— 41.347	+ 2.0475	36.27
12 mo. 11.	62 77	40 5 57.82	— 5 30.944	+ 11.025	37.40
12 mo. 16.	48 51	39 56 44.92	+ 4 24.307	— 31.5	37.78
12 mo. 18.	48 51	39 56 44.923	+ 3 36.582	+ 17.797	39.80
12 mo. 18.	62 77	40 5 57.46	— 5 36.966	+ 18.27	38.77
12 mo. 19.	48 51	39 56 44.92	+ 3 37.5338	+ 18.1115	39.97
12 mo. 28.	48 51	39 56 44.79	+ 4 5.7883	— 18.86	36.72
12 mo. 28.	62 77	40 5 56.818	— 5 2.18	— 17.64	37.04
1883.					
1 mo. 2.	261 279	39 54 46.794	+ 6 5.913	— 15.281	37.44
1 mo. 11.	261 279	39 54 51.519	+ 6 10.366	— 21.735	40.15
1 mo. 12.	530 550	39 59 58.852	+ 54.495	— 7.087	41.26
1 mo. 22.	530 550	39 59 56.380	+ 50.248	— 5.985	40.64
2 mo. 2.	530 550	39 59 52.351	+ 1 6.02	— 20.947	38.87
2 mo. 5.	466 475	40 10 41.431	— 10 19.478	+ 15.12	37.07

Date.	Catalogue No. of Stars.		½ (δ + δ').			Micrometer Correction.			Level Correction.		Latitude.
1883.											
2 mo. 5.	489	495	39	58	56.523	+	1	12.567	+	31.815	39.91
"	530	550	39	59	58.002	+		21.5061	+	22.68	43.19
"	567	569	40	6	19.803	—	6	5.949	+	23.153	36.99
2 mo. 8.	466	475	40	10	44.976	—	10	11.925	+	3.78	36.83
"	467	475	40	12	12.959	—	11	37.301	+	3.78	39.44
"	489	495	39	58	55.196	+	1	41.325	+	3.15	39.67
"	530	550	39	59	56.906	+		43.75	+	0.787	40.84
"	567	569	40	6	20.181	—	5	45.5889	+	3.15	39.70
"	577	591	39	51	35.175	+	9	9.149	—	3.44	40.88
"	578	591	40	5	10.217	—	4	27.16	+	3.44	39.62
2 mo. 9.	466	475	40	10	44.976	—	9	9.378	+	7.56	43.16
"	489	495	39	58	55.198	+	1	40.150	+	3.44	38.79
"	567	569	[illegible]	6	20.1325	—	5	45.9948	+	7.245	41.89
"	642	710	39	56	19.1645	+	4	13.733	+	6.3	39.20
"	607	710	39	54	34.2665	+	6	1.498	+	6.3	42.46
2 mo. 12.	466	475	40	10	44.011	—	9	46.635	+	7.56	41.97
"	489	495	39	58	55.782	+	1	33.044	+	6.615	35.43
"	540	570	39	59	56.5465	+		41.1793	+	3.15	40.84
"	567	569	40	6	20.8575	—	5	43.809	+	2.3025	39.41
"	578	591	40	5	4.822	—	4	29.769	+	2.677	37.73
"	607	710	39	54	34.5405	+	6	10.165	+	.945	45.65
2 mo. 13.	466	475	40	10	44.041		10	13.547	+	8.15	37.11
"	567	569	40	6	20.3575	—	5	34.0215	—	9.135	37.29
"	607	710	39	54	34.5405	+	6	22.1985	—	14.49	42.18
2 mo. 23.	540	550	39	59	57.118	+		44.928	+	787	42.88
"	753	757	39	56	7.521	+	4	37.888	—	4.882	40.01
2 mo. 27.	530	550	39	59	57.091	+		44.20	+	3.1	44.83
3 mo. 8.	812	822	39	54	18.609	+	6	28.125	—	2.047	44.69
3 mo. 13.	779	812	40	0	26.399	+		3.357	+	11.495	41.27
"	779	844	39	53	53.759	+	6	35.276	+	11.025	40.06
"	779	859	39	56	43.715	+	3	47.381	+	7.718	38.81
3 mo. 14.	812	822	39	54	19.105	+	6	24.096			43.20

The mean of these 76 results gives the latitude of the Observatory

40° 0′ 40.085.

Assuming them all to be of equal weight, the probable error of a single observation is 1.706″ and of the final result .191″.

NOTE.—The value of the longitude of the Observatory, standing on our books, but obtained, we do not know how, is 6m. 59.3 sec. East of Washington. At the time of the Transit of Venus, Washington time was telegraphed to our railroad station, distant one-half mile from the Observatory and compared with our local time. The mean of three days' comparisons gave a difference of 6m. 59.6 sec.

On a Crinoid with Movable Spines. By Henry S. Williams.

(Read before the American Philosophical Society, April 20, 1883.)

Among the rarer forms of the second fauna of the upper Devonian, at the base of the Chemung group, Ithaca, N. Y., is a Crinoid with some interesting features.

In its general characters it agrees with the family *Platycrinidæ* of Rœmer, and falls under the section *Hexacrinites* as defined by Wachsmuth and Springer in Revision of the Palæocrinoidea, Pt. II, p. 56.

It differs from the genus *Hexacrinus* Austin, as generally understood, in possessing a well defined third primary radial similar in size to the second, and from which the free arms abruptly diverge.

In respect of one character it differs fundamentally from all the known representations of the genus, section or family; and, in fact, from all hitherto described Crinoids, in the possession of slender, acicular spines which were free from the plates, and were evidently articulated by some means upon elevated pitted tubercles on the surface of the plates of the calyx, vault and free arms.

We find so-called spines on a few Crinoids, on the plates of the vault in the genera Dorycrinus and Amphoracocrinus, and upon the calyx plates of Rhodocrinus and other genera.

In all these cases, however, the "spines" or tubercles consist merely of thorn-like expansions of the plates, and, so far as I can learn, there is no recorded evidence of the occurrence upon any true Crinoid, of free spines articulated to the plates as in the Echinoids.

In the absence of the spines themselves, the low rounded tubercles, pitted at the apex, suggest resemblance to the mamelon of the Echinoids, but in the specimens herein described, the spines as well as the tubercles are represented.

Other specimens have been examined in which the pitted tubercles alone are seen: the spines have been found in only a single locality, but there upon several individuals.

These specimens, like most of the fossils of the fine sandy shales of the upper Devonian, are in the condition of hollow impressions preserving scarcely a particle of the original substance of the test, but the impressions are beautifully perfect, showing the finest details of surface marking and configuration. On the impressions of some of the slender spines, fine longitudinal striæ, invisible to the naked eye, are distinctly seen with a good lens.

Palæontologists accustomed to throw aside these hollow impressions of fossils in the Chemung rocks, as poor and worthless specimens, will be surprised at the perfection in which all the surface details, external and internal are preserved.

Many minute characters are visible in such specimens that are rarely seen in so called perfect specimens from limestone rocks, where the immediate surface is very generally removed in taking the fossil from the matrix.

In the present case the specimens break along the cavities from which the test has been dissolved, the inner and outer surfaces of the plates both appearing, and the spines in place. That they were true spines, and not prolongations of the plate surface is evidenced by the fact that the spines, though in place, like bristles radiating from the surface, are in no case entirely continuous with the impressions left by the removal of the plate there is always a thin film of matrix separating the base of the spine from the apex of the tubercles, to which in several cases they are closely approximate.

When the spines are preserved in relation to the vault, although the specimen was crushed and thrown out of normal shape, the vault plates and their spines were held together during the process of fossilization.

The evidence is such as to suggest that the spines were united to the plates by a tough ligamentous attachment which withstood decomposition long after the fossil was buried.

The calyx plates were thin and frequently occur detached, but the basal plates were thickened toward the center of the disk where they joined the column, and were generally preserved together, though separate from the rest of the calyx.

In studying this genus, I have examined several specimens which agree with the typical form in the general character of the plates and the arms in one case, and possess the pitted tubercles on the surface.

The most important among these is the original specimen of a figure issued by the New York State Museum with the name *Platycrinus? punctobrachiatus.*

The original is in the Museum of Cornell University. The name was proposed by Prof. Hall, but, as he informs me, the species was never described. This, with several other undescribed spècies, was photographed and the plate was privately distributed abut 1872, with names attached, but with no descriptions. The arms, the shape of calyx, and the plates that were preserved, correspond in general with the *A. Ithacensis*, but the tubercles on the calyx plates are finer, more numerous, and the pitting very indistinct, and the basal plates are relatively larger than in the typical specimens of that species. Hence we are led to believe that the Hamilton species is distinct from the Chemung specimens, and even if it were properly described and published, it is probably safe to regard it as a distinct species. Although the specimen shows no traces of the free spines, the nature of the tubercles leave little doubt of a generic identity with *Arthroacantha Ithacensis*, and the Hamilton form may be called *Arthroacantha punctobrachiata.*

In the Museum of Cornell University are two specimens, each a portion of the basal disc, which appear to be identical with *A. punctobrachiatus.*

One is marked *Moscow shale*, locality not designated ; the other is marked *Hamilton Period, Delphi, N. Y.*, and is on a soft dark shale with specimens of *Pholidops.*

Another specimen, generically identical, but too imperfect for specific determination, is in the collection of Prof. S. G. Williams, from the Hamilton group at Ensinore Glen, Owasco lake, N. Y.

Dr. Charles Wachsmuth of Burlington, Iowa, informs me of having examined specimens of apparently the same species, said to have come from Hamilton group, Ontario, Canada.

A single calyx plate from High-point, Ontario Co., N. Y., has large, coarse tubercles, and the plate is evidently from a much larger specimen than any seen at Ithaca, or in the Hamilton group, it is probably a distinct species.

A few detached calyx plates with similar surface markings, but proportionately longer and narrower than those of *A. Ithacensis*, were found in another exposure of the rocks near Ithaca.

The tubercles were few and scattered, this may represent another species. The generic characters of this new type of Crinoid may be defined as follows :

Arthroacantha, nov. gen.

(From 'ἄρθρον, articulation and 'ἄκανθα spine.) Calyx obconical or broadly cup-shaped ; height about equal to the breadth. Basal disc broad, shallow, hexagonal, composed of three subequal plates.

Following the basal disc are six large subequal plates, five of which are primary radials, and the sixth is the anal.

The first radials are slightly higher than broad with gently diverging sides, the upper margin excavated by a deep covered notch occupying about one third the total width of the upper edge.

In this notch lie the second radials, small and short plates which arch outward and continue upward the rounded carination that begins on the upper part of the first radial.

The third radial is triangular, smaller than the second and supports the first plates of the free arms which start out from the radial at a broad angle.

The arms are ten, and, in the typical species are several times as long as the height of the calyx, and bifurcate at least twice, and broadly diverge at each branching.

They are composed of plates which are narrowly wedge-shaped at the base of the arm, the first two or three reach across the breadth of the arm, but seriatim they become shorter, the wedge points more blunt, and the outer portion of the margin more nearly parallel, and for the main part of the arm the plates interlock along the median line, forming a zigzag suture, the points of the plates from each side reaching less than two-thirds across the surface of the arm.

Each arm plate bears a slender pinnule of five or more joints.

The anals are a little narrower than the first radials, and have less diverging sides.

The vault is composed of numerous small plates, and was probably low and arching.

The surface of the calyx plates is beset with low scattered, rounded tubercles, pitted at the apex.

The same tubercles are seen on the plates of the vault, a single tubercle for each plate.

Upon the vault there are five narrow spaces, without tubercles, radiating from the center; they consist of two rows of interlocking plates which were probably thinner than the spine-bearing plates; all the intervening plates have tubercles.

Along the upper rim of the calyx is a row of small plates which lack the tubercles ; also, the tubercles are wanting on the second and third

radial plates. The arm plates pretty generally have a small tubercle for each plate, but there is an occasional exception.

From these tubercles proceed slender, acicular spines, bristling outward from the calyx and arms, and upward from the vault.

These spines were evidently movable, and articulated by ? ligaments or ? muscle upon the pitted tubercles. The spines are also pitted at their bases.

The typical species, *A. Ithacensis*, is from the base of the Chemung group at Ithaca, N. Y., from a fine, sandy shale, containing *Spirifera mesocostalis*, *Productella speciosa*, *Strophodonta mucronata*, and other Chemung fossils, and the specimens are in the museum of Cornell University.

Arthroacantha Ithacensis, n. s.

This name is proposed for the typical species upon which the genus *Arthroacantha* is founded, and the imperfection of the material and the actual variation among the few specimens seen create considerable doubt as to what may be the permanent characters which distinguish the typical form from other representatives of the genus. I will give therefore a particular account of the size and proportions of the parts of the typical specimens, and remark upon the variations observed.

The general shape and features are described in the generic diagnosis.

The typical species has the following dimensions:

	MM.	
Calyx, height	9.5	
breadth	13.5	
Arms, thickness at base	1.4	
estimated length	45.0	
Stem, thickness at junction with calyx	1.9	
Basal. radius from center of disc to base of 1st radial	4.5	
1st radial, height	4.5	
2d and 3d radials together	1.1	
1st radial, width at base	5.0	
" " top	7.0	
Tubercles, diameter about	0.6	
number on one basal plate		16–18
" " one 1st radial		21
Spines, length of longest	12.8	
diameter at base	0.4	

The arms have ten to fifteen joints before they bifurcate. The calyx plates are marked on the inside by several distinct lines parallel with each other and with the outline of the plate, arranged concentrically like lines of growth. This feature is not seen on the specimens from the Hamilton group.

There is considerable difference in size among the several specimens from the typical locality, though the majority of specimens are about the

dimensions given above. A large basal disk is seen with a radius of 12.2 mm., but with proportions of the other specimens.

Although the specimens show more or less distortion from pressure, it is evident that the basal disk formed a low shallow cup, the depth of which was about one-quarter the diameter.

The length of spines vary for the same individual. Those within the protection of the arms, from the vault plates, are more frequently preserved, and are longer than representatives of calyx spines seen on these specimens, but one calyx spine is thicker than any vault spine, and is broken off; judging from this and the larger size of the tubercles, it is probable that the calyx spines were fully as long and strong as those on the vault. The spines are all very straight, slender, acicular, tapering evenly to a sharp point, and are finely longitudinally striate on the surface.

The number of the tubercles to each plate varies somewhat, and, comparing specimens of different size, it seems probable that their distribution was uniform, and that the number increased with the size of the specimen.

This species differs from the *Arth. punctobrachiata* of the Hamilton group in the more distinct and less numerous tubercles on the surface of the calyx plates; the smaller size of the tubercles leads to the inference that the spines were smaller in the Hamilton form; the calyx plates were apparently thicker in the Chemung species, and the second and third radial of the specimen *Arth. punctobrachiata* are higher than those of *Arth. Ithacensis.*

In all these comparisons normal variation (of which we are ignorant), the effects of different habitat upon relative development of parts, and the distortion incident to fossilization, and the very limited and imperfect nature of the material, lead us to speak with diffidence both as to specific character and as to specific limits.

The character of movable spines, were it not so anomalous for the whole order, might be regarded as of only specific value; on the other hand, from a theoretical point of view it would not be unreasonable to establish a distinct family for Crinoids possessing this Echinoid character.

I have taken the view that for practical purposes the generic distinction of this from closely related genera is the best that can be done with the present material.

The character of a vault composed of two sets of plates arranged in ten radiating and alternate series is suggestive, and calls for further investigation.

I have discovered on one of the specimens—somewhat crushed, but exhibiting the main part of the vault and spines in place—five radiating rows of plates upon which there are no tubercles. In crushing, the folding has taken place along the line of these rays, from which it is inferred that these plates were thinner than the spine-bearing plates which fill the spaces between them. These smooth plates seem to consist of two rows

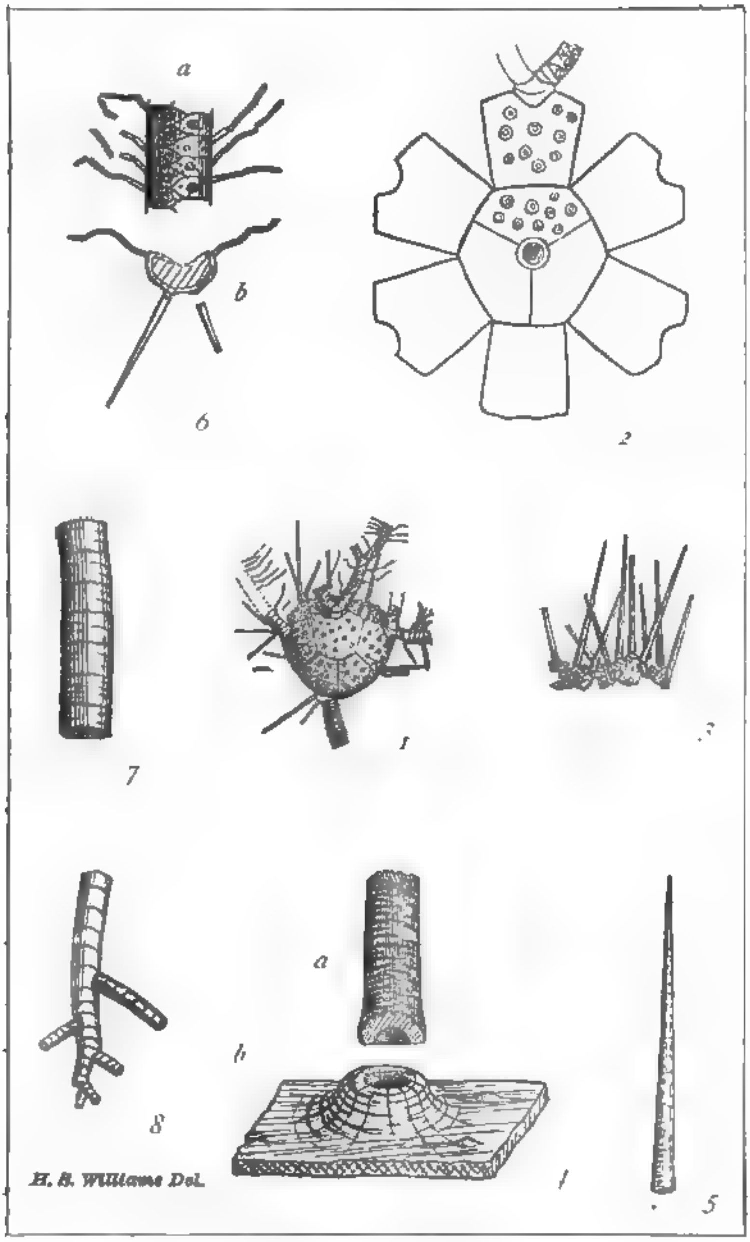


PLATE ILLUSTRATING ARTHROACANTHA ITHACENSIS, NOV. GEN. ET SP.

of interlocking plates radiating from near the center to the circumference of the vault.

This observation persuades me that it is not improbable that the original plates of *Lepidocentrus eifelianus*, described and figured by Johannes Müller, from the Eifel limestone of Rommersheim, which were detached plates associated with spines similar in nature to those just described and borne upon similar tubercles, were plates from the vault of a true Crinoid like Arthroacantha.

We have here a possible clue to a relationship between true Crinoids and Perischœchinidæ, which is worth following up by any palæontologist who may have good specimens of these rare forms of Echinodermata.

EXPLANATION OF PLATE.

Arthroacantha Ithacensis, nov. gen. et sp.

Fig. 1.—Calyx and part of arms, showing spines arising from plates of calyx, vault and arms.
Fig. 2.—Diagram of the elements of the calyx.
Fig. 3.—Enlarged view of part of the vault with spines attached.
Fig. 4.—Enlarged tubercle (*b*) and base of a spine (*a*), showing pit in top of former and in base of latter.
Fig. 5.—Spine about three times natural size.
Fig. 6.—Arm-plates. (*a*) A few joints of arm; external view, showing tubercles and jointed pinnules. (*b*) Section of same.
Fig. 7.—Section of the stem at a distance from the calyx.
Fig. 8.—Lower termination of stem. All enlarged except Fig. 1.

The Role of Parasitic Protophytes. Are they the Primary, or the Secondary Cause of Zymotic Diseases? By W. N. Lockington.

(Read before the American Philosophical Society, April 6, 1883.)

Parasitic unicellular organisms or microbes, usually considered to belong to the vegetable kingdom, are found, in some form or other, in the interior of the higher animals, both when in their normal state of health, and when suffering from disease.

Certain rod-like forms have received the generic name of *Bacillus;* spherical globules that of *Micrococcus*, while other shapes have been entitled *Vibrio, Bacterium*, and *Cladothrix*. The idea of those who gave these titles was evidently that each of these forms is actually distinct under existing circumstances.

Nomenclature has even proceeded farther than this, since such binomials as *Bacillus anthracis* exist.

During the last few years the microscope has been largely employed in the investigation of diseased tissues, especially in cases of those diseases called "zymotic;" and the result of this examination has been to show that certain specific forms of disease are invariably accompanied by what appear to be specific types of microbes—or at any rate by types that are constant in their relation to the disorder they accompany.

In this way Pasteur has made us acquainted with the parasite which accompanies anthrax, charbon, or malignant pustule, and with some others, Laveran has described and figured that of malaria, and Koch has shown that consumption has also its parasitic companion.

So generally have special forms been found associated with special diseases, and so invariably have these special forms been found to increase in number of individuals as the disease with which they are associated has increased in severity, that a large proportion of scientific and medical men have arrived at the conclusions that every *inflammatory* disease (if not every disease) has its *specific* parasite; and that the parasite is the cause of the disease.

This explanation certainly lies upon the face of the facts, but a little consideration will show that neither the *specific* nature of the parasite, nor its direct causation of the disease, are proved by any series of observations yet on record.

Observations upon the *higher* animals have conclusively proved that they are subject to considerable changes caused by their environment.

Within the limits of a single so-called species occur so many variations that the definition of a species has become difficult. Besides those variations due to sex and to age; individual, racial, and varietal differences occur, to such an extent as to render the systematic arrangement of living forms a most bewildering task, and one respecting which no two biologists agree.

These variations right and left of the average of a species are admitted on all hands to be produced by natural forces, organic and inorganic, by gravity, heat, cold, moisture or drouth, plenty or lack of food, confinement or freedom, cultivation (which is an environment of man's making) or heredity, which is the effect of the continued environment of ancestors.

No man can look dispassionately at his own physical and mental condition without acknowledging that, leaving heredity aside, he is what he is on account of what he has experienced.

The changes of cell-structure which take place in the arm of a man who abandons the yard-measure for the blacksmith's hammer would, could they be examined with the microscope in the same way that we can watch the changes of an amœba, be seen to be a thousand-fold greater and more complicated than those of that rhizopod.

As instances of what a change of environment can do in creatures built up of many thousand cells, each cell as complex as is the entirety of the parasitic organisms we are inquiring into, the following will suffice: The

same species of trout attains a larger size in large rivers than in small streams; anadromous salmon of a large species have, when by accident confined within a small fresh-water lake, in a few years so altered, becoming sexually mature when quite small, that a naturalist who did not know the cause might take them for a new species; fishes confined within a space so narrow that normal growth was impossible, yet supplied with food, have grown to fit the space; the clear silvery tints and graceful forms of salmon when in the sea are so unlike the muddy colors and misshapen outlines presented by the same individuals after ascent of a river that observers have founded on them many false species; and the larva of the conger eel becomes at times converted into a transparent, colorless pelagic fish that has received the name of *Leptocephalus Morrisii.*

Is it not reasonable to suppose that the outline of a plastic atom of protoplasm, bounded only by a delicate pellicle, is more readily amenable to the influences surrounding it than that of the million-celled creatures which are known to change so greatly?

The vegetable kingdom offers examples of variation as striking as those of the animal.

It is as hard to find two leaves of the same plant exactly alike as it is to find two Dromios. The stem-leaves and root-leaves of the same herbaceous plant differ more from each other than from the corresponding leaves of a kindred species. In some trees, as the ivy and the mulberry, the play of form is so great, that one unacquainted with the facts would certainly believe that forms gathered from the same stem belonged to different species. Each leaf, as truly as each human being, has its own particular environment, its share of light, heat, nutrition, etc., and these work changes in its form.

The change effected by the environment upon a plant goes further than form, size, or color, and extends to the nature of its secretions, so that plants which, when grown under certain conditions, are good food for man and beast, become toxic under other conditions. This is true of many of our garden vegetables; and, to come nearer to our microscopic organisms, it is true of certain many-celled fungi, such as the common agaric of the meadows.

In the latter case the fungus is on all hands allowed to be the same, yet while one specimen it innocuous, another is toxic.

Would it be very remarkable if it should be proved that an innocent one-celled microbe, surrounded with diseased and poisonous pabulum, should, if able to resist the influences around it without perishing, become poisonous itself?

Against the usual form of the germ theory, with its specific germs inducing specific diseases, it is allowable to put forth the following:

The microbes that swarm within the body of the victim of a zymotic disease, are either the lineal descendants of those which inhabited the same body when in health, or are the lineal descendants of those which once dwelt in some other

body when in health; and, if poisonous in their nature, have been so rendered by the poisonous nature of the secretions around them.

Organisms placed in the midst of matter that has undergone a chemical change, and accustomed to feed upon the products of disease, are likely to introduce that disease if themselves introduced into a previously healthy body.

Their substance is permeated with the diseased secretions, their surface is covered with them. They have fed upon abnormal products, therefore they excrete abnormal products, and, if placed within a healthy animal, are apt to start within it the same unhealthy metabolism to which they are acclimated.

Even if the parasitic germs have not themselves yet become toxic, it is a physical impossibility to introduce them unaccompanied by the virus that surrounds and permeates them.

Yet the primary cause of the disease is an abnormal change in the processes of life, affecting first the animal, and afterwards the parasite.

All analogy is, as has been shown, in favor of this view, and no observations yet made have weakened, still less disproved, analogies in harmony with evolutional facts.

Many well-known medical men, notably Dr. Lionel Beale, and Dr. Benjamin Richardson, refuse to believe in the potency of mysterious specific germs peopling air, water and soil, and ready at any moment to enter upon a work of wholesale destruction, and recently Dr. Formad, of this city, has announced his adherence to the older and more rational view, at least in the case of consumption.

We need no microscope, and no doctor, to assure us that germs are not the primary cause of most of the ills that flesh is heir to. He would be a bold man who would dare attribute the evils following excessive indulgence of any kind to the presence of parasites; the catarrh that follows facing a rough north-easter, or "cooling off" in a draught can scarcely be due to germs; nor can the pneumonia that succeeds a thorough wetting and chilling; the rheumatism of the muscular man who has habitually exposed himself to cold and damp; or the headache that punishes intellectual excess, be set down as caused by microbes.

Yet these disorders are accompanied with more or less of that inequality of the bodily processes, that undue activity in one spot, and stagnation in another, which constitutes inflammation; and there is little doubt that, were a microscopic examination made, it would be found that microbes were present, probably in larger numbers than usual in a state of health.

Between these ordinary ailments and epidemic diseases there is no provable distinction in kind. The products of disease, whether particles of the diseased organism, or parasites become diseased by a residence in that organism, are dangerous to the health of others, and the danger increases in proportion to the virulence of the disease.

Diseases are processes of dissolution, and dissolution must occur, sooner or later, as the complement of individual evolution.

The role of microscopic parasites is probably similar to that of the more tangible *tæniæ* and other worms that live as commensals within the body, devouring the nutriment intended for it; or, at the very worst, they are feeders upon the secretions of their host. In either case, they are fed at his expense. To one in thorough health they do little harm, but become a burden to those of weaker powers, and may become, in those attacked with a grave disorder, so diseased themselves that they may act as carriers of the disease to previously healthy bodies.

The power possessed by these parasites, taken from the victim of an infectious disease, of producing descendants which, for several generations, are capable of reproducing that disease, is often pointed to as a proof both of the specific nature of the parasite, and of its potency as the primary cause of the disease.

Yet these facts, when looked at properly, tend to prove the reverse.

The presumably toxic microbes, removed from their accustomed pabulum, reproduce themselves, it is true, in healthy infusions, which by their presence are rendered toxic, but at each removal to a fresh environment some of the toxic power is lost, until at last the virus has become so attenuated that it can safely be used as a medium of inoculation (as has been practised largely by Pasteur upon domestic animals) reproducing the original disease in a mild form, and thus (in some way not easy to explain) ensuring the subjects treated with it against the fatal form of the disease.

What is this gradual enfeeblement of the toxic powers of the parasite but its gradual return toward its normal condition—toward the neutral properties and probably toward the external appearance presented by its ancestors when they dwelt within a healthy animal?

Let the cultivation proceed for a sufficient number of generations, and the reversion will be complete.

Observers, principally chemists, who have studied the microbes of disease, have figured their forms, and in some cases have registered the transformations of a generation; but much more than this is necessary to prove their specific distinctness, or their direct connection with the disease.

If, after an examination of hundreds of individual animals, some in health, others in every stage between health and the crisis of the disease, and others in the various stages of recovery, no transition form is in any one instance noted—no microbe intermediate in character between that of health and that found in the disease; the evidence, though still negative, will be in favor of the ordinary germ theory, but if in only one animal among hundreds intermediate forms are found, that one instance will be positive evidence in favor of the views here advocated; since the diseased form, when once produced, can reproduce its characters for several generations.

Microscopic examinations of the cultured organisms up to the hundredth generation would throw some light on the subject.

Identity between a micrococcus-form and *bacillus*-form has already been noted.

M. Miguel, who has recently studied in a most thorough manner the germs found in the air, gives figures of the development of an organism which, at one stage of its life, has all the characters of a very long *bacillus*, and afterwards by segmentation into spherules of equal size, forms chaplets of *micrococci*, liable to separate into small groups.

The editor of the *Revue Scientifique*, that stronghold of the microbe contagion theory, admits, in a late issue, that the forms found in disease are probably varieties of habitat, and not species, yet still considers them as the cause of the diseases they accompany.

After admitting the great variability of these simple organisms, in accordance with their habitat, is it not arguing in a circle to maintain that varieties caused by certain conditions are themselves the primary cause of those conditions?

On the Reversion of Series and its Application to the Solution of Numerical Equations.

By J. G. Hagen, S. J. Prof. College of the Sacred Heart, Prairie du Chien, Wisconsin.

(*Read before the American Philosophical Society, April 6, 1883.*)

In a treatise entitled "Die allgemeine Umkehrung gegebener Functionen," which was published in 1849, Professor Schlömilch maintains, that all the methods of reversing series, based upon the theory of Combinations, fail in the point of *practical application* and that even Lagrange's formula presents an *unfavorable form* of such reversions. The author then proceeds to develop two new methods of reversing any given function, the one by means of Fourier's series, the other by definite integrals. In a theoretical view, Professor Schlömilch's methods are no doubt preferable to all the ancient ones on account of both their generality and their simplicity ; yet when there is question about computing the numerical values of the coefficients of a reversed series, it should not be forgotten, that in most cases these definite integrals, in spite of their elegant form, can not be computed except by development, thus in many cases causing even greater trouble than the old method of combinations in the case of algebraic functions.

The treatise here published does not claim to furnish a new method, but is intended to give the recurring formula for determining the coefficients of the reversed series such a perspicuous form as to render its practical application easy, and then to apply the same to the solution of numerical equations.

Paper I

1. Given the series $y = \sum_{r=0}^{m} A_r x^r$ to find the reversed series $x = \sum_{i=0}^{i=\infty} B_i y^i$, where m and B are unknown. Replacing x by the latter series, we obtain

$$y = \sum_{r=0}^{m} A_r \left[\sum_{i=0}^{\infty} B_i y^i \right]^r$$ or applying Waring's formula,

$$y = \sum_{r=0}^{m} A_r \pi(r) \sum \frac{B_0^{a_0} B_1^{a_1} \ldots B_\mu^{a_\mu}}{\pi(a_0)\pi(a_1)\ldots\pi(a_\mu)} y^{0a_0 + 1a_1 + 2a_2 + \ldots + \mu a_\mu}$$

In this formula $\pi(r) = 1\cdot2\cdot3 \ldots r$, according to the notation of Gauss, and the integers $a_0, a_1, \ldots a_\mu$ represent all such combinations of the numbers $0, 1, 2, \ldots$ as satisfy the condition

$$a_0 + a_1 + a_2 + \ldots + a_\mu = r.$$

This last formula is an identical equation and, according to the theorem of Indeterminate Coefficients, may be resolved into the following conditions:

1 Case. $$0a_0 + 1a_1 + 2a_2 + \ldots + \mu a_\mu = 0.$$

This equation admits of the following combinations:

a_0	a_1	a_2	a_3	r
0	0	0	0	0
1	0	0	0	1
2	0	0	0	2
.	.	.	.	.

hence we have the condition

$$\sum_{r=0}^{m} A_r \pi(r) \frac{B_0^r}{\pi(r)} = 0 \text{ or } \sum_{r=0}^{r=m} A_r B_0^r = 0. \qquad (1)$$

Though this equation is of the mth degree with regard to B_0, yet for the reversion of series, but one of its roots is fit, because there is *but one way of developing y into a series of ascending powers of* x, and indeed we find that B_0 is to satisfy still another condition.

Putting $y = 0$ we have $x = A_0$, hence

$$\sum_{s=0}^{s=\mu} B_s A_0^s = 0.$$

In the special case $A_0 = 0$ we have $B_0 = 0$.

2. Case. $$0a_0 + 1a_1 + 2a_2 + \ldots + \mu a_\mu = 1.$$

This case admits of the following combinations:

a_0	a_1	a_2	a_3	a_4	r
0	1	0	0	0	1
1	1	0	0	0	2
2	1	0	0	0	3
.	.	.	.	.	

Hence we have the second condition

$$\sum_{r=o}^{r=m} A_r \, \pi(r) \; \frac{B_0 \; B_1}{\pi(r-1)} = 1. \tag{2}$$

3. Case. $\qquad 0a_0 + 1a_1 + 2a_2 + \ldots + \mu\, a_\mu = 2.$

This equation admits of the combinations :

a_0	a_1	a_2	a_3	a_4	r	a_0	a_1	a_2	a_3	a_4	r
0	0	1	0	0	1	0	2	0	0	0	2
1	0	1	0	0	2	1	2	0	0	0	3
2	0	1	0	0	3	2	2	0	0	0	4
.	.	.	.	.	.	.	.	.	.	.	.

Hence the third condition is

$$\Sigma A_r \, \pi(r) \left[\frac{B_0^{r-1} \, B_2}{\pi(r-1)\;\pi(1)} + \frac{B_0^{r-2} \, B_1^2}{\pi(r-2)\;\pi(2)} \right] = 0. \tag{3}$$

4. Case. $\qquad 0a_0 + 1a_1 + 2a_2 + \ldots + \mu\, a_\mu = 3.$

The combinations of this case are the following :

a_0	a_1	a_2	a_3	a_4	a_5	r	a_0	a_1	a_2	a_3	a_4	a_5	r	a_0	a_1	a_2	a_3	a_4	a_5	r
0	0	0	1	0	0	1	0	1	1	0	0	.	2	0	3	0	0	etc.		3
1	0	0	1	0	0	2	1	1	1	0	0	.	3	1	3	0	0			4
2	0	0	1	0	0	3	2	1	1	0	0	.	4	2	3	0	0			5
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			.

Hence the fourth condition

$$\sum_{r=o}^{r=m} A_r \, \pi(r) \left[\frac{B_0^{r-1} \, B_r}{\pi(r-1)\;\pi(1)} + \frac{B_0^{r-2} \, B_1 B_2}{\pi(r-2)\;\pi(1)\;\pi(1)} + \frac{B_0^{r-3} \, B_1^3}{\pi(r-3)\;\pi(3)} \right] = 0. \tag{4}$$

5. Case. $\qquad .0a_0 + 1a_1 + 2a_2 + \ldots + \mu\, a_\mu = 4.$

Here we have the following possible combinations :

a_0	a_1	a_2	a_3	a_4	a_5	r	a_0	a_1	a_2	a_3	r	a_0	a_1	a_2	a_3	r
0	0	0	0	1	0	1	0	1	0	1	2	0	2	1	0	3
1	0	0	0	1	0	2	1	1	0	1	3	1	2	1	0	4
2	0	0	0	1	0	3	2	1	0	1	4	2	2	1	0	5
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

a_0	a_1	a_2	r	a_0	a_1	a_2	a_3	r
0	4	0	4	0	0	2	0	2
1	4	0	5	1	0	2	0	3
2	4	0	6	2	0	2	0	4
.	.	.	.	.	.	.	.	.

Hence the fifth condition :

$$\sum_{r=o}^{r=m} A_r \, \pi(r) \left[\frac{B_0^{r-1} \, B_4}{\pi(r-1)\;\pi(1)} + \frac{B_0^{r-2}}{\pi(r-2)} \left(\frac{B_1 B_3}{\pi(1)\;\pi(1)} + \frac{B_2^2}{\pi(2)} \right) + \frac{B_0^{r-3} \, B_1^2 \, B_2}{\pi(r-3)\;\pi(2)\pi(1)} \right.$$

$$+\frac{B_0^{r-4}\, B_{(4)}}{\pi(r-4)\, \pi(4)}\Bigg] = 0, \tag{5}$$

and so on.

Note.—The lower limit of r may be put $= 0$, because all those terms in which π contains a *negative* argument, are zero.

§2. The equations (1) to (5) may be transformed in the following way. We put for brevity's sake

$$\Sigma_\delta = \sum_{r=\delta}^{r=m} \binom{r}{\delta} A_r\, B_0^{r-\delta} = A_\delta + \ldots, \tag{6}$$

where

$$\binom{r}{\delta} = \frac{r\,(r-1)\,(r-2)\ldots(r-\delta+1)}{1\;.\;2\;.\;3\;\ldots\ldots\;\delta}$$

according to the notation of *Euler.** For numerical computations we then obtain from (6)

$$\left.\begin{aligned}
\Sigma_1 &= A_1 + 2\, A_2\, B_0 + 3\, A_3\, B_0^2 + 4\, A_4\, B_0^3 + \ldots \\
\Sigma_2 &= A_2 + 3\, A_3\, B_0 + 6\, A_4\, B_0^2 + \ldots \\
\Sigma_3 &= A_3 + 4\, A_4\, B_0 + \ldots \\
\Sigma_4 &= A_4 + \ldots
\end{aligned}\right\} \tag{7}$$

Thus the conditions (1) to (5) present themselves in the more perspicuous forms

$$\left.\begin{aligned}
&\Sigma_0 = 0 \\
&B_1\, \Sigma_1 = 1 \\
&B_2\, \Sigma_1 + B_1^2\, \Sigma_2 = 0 \\
&B_3\, \Sigma_1 + 2\, B_1\, B_2\, \Sigma_2 + B_1^3\, \Sigma_3 = 0 \\
&B_4\, \Sigma_1 + 2\,(B_1\, B_3 + \tfrac{1}{2}\, B_2^2)\, \Sigma_2 + 3\, B_1^2\, B_2\, \Sigma_3 + B_1^4\, \Sigma_4 = 0.
\end{aligned}\right\} \tag{8}$$

The law of these series being evidenced from inspection, we deduce the next following conditions :

$$B_5\, \Sigma_1 + 2\,(B_1\, B_4 + B_2\, B_3)\, \Sigma_2 + 3\,(B_1^2\, B_3 + B_2^2\, B_1)\, \Sigma_3 + 4\, B_1^3\, B_2\, \Sigma_4 + B_1^5\, \Sigma_5 = 0$$

$$B_6\, \Sigma_1 + \pi(2)\left(B_1 B_5 + B_2\, B_4 + \frac{B_3^2}{\pi(2)}\right)\Sigma_2 + \pi(3)\left(B_1 B_2 B_3 + \frac{B_1^2}{\pi(2)}\, B_4 + \frac{B_2^3}{\pi(3)}\right)$$
$$\times\, \Sigma_3 + \pi(4)\left(\frac{B_1^3}{\pi(3)}\, B_3 + \frac{B_1^2}{\pi(2)}\, \frac{B_1^2}{\pi(2)}\right) \Sigma_4 + 5\, B_1^4\, B_2\, \Sigma_5 + B_1^6\, \Sigma_6 = 0,$$

and in the general form

$$B_\mu\, \Sigma_1 + \pi(2)(B_1\, B_{\mu-1} + \ldots)\, \Sigma_2 + \pi(3)(B_1 \ldots\ldots)\, \Sigma_3 + \ldots + B_1^\mu\, \Sigma_\mu = 0,$$

each term with the sign Σ_ν having the factor $\pi(\nu)$ and each B^σ having the denominator $\pi(\sigma)$. The factors of Σ_ν are always ν in number, and the sum of their indices μ.

There is no difficulty in solving the equations (8), except the first,

* Acta Petropolitana, V. 1, p. 89. Though his notation is not much used in American text-books, it is found very handy in operating on series.

which is of the *m*th degree and will be considered presently. The other equations give the following solutions:

$$\left.\begin{aligned}
B_1 &= +\frac{1}{\Sigma_1} \\
B_2 &= -\frac{1}{\Sigma_1^3}\Sigma_2 \\
B_3 &= +\frac{1}{\Sigma_1^5}(2\,\Sigma_2^2 - \Sigma_1\,\Sigma_3) \\
B_4 &= -\frac{1}{\Sigma_1^7}(5\,\Sigma_2^3 - 5\,\Sigma_1\,\Sigma_2\,\Sigma_3 + \Sigma_1^2\,\Sigma_4),\ \text{etc.}
\end{aligned}\right\} \quad (9)$$

The formulas show, first, that in general we shall have $\mu = \infty$, and secondly, that the series of the coefficients *B* decreases the faster the larger Σ_1 is. For the quotient $B_{\mu+1} \div B_\mu$ is of the same order as $1 \div \Sigma_1$. Hence a few terms will suffice to compute *y* as often as the coefficient A_1 is large in comparison to the following coefficients.

Now as to the condition

$$\Sigma_0 = \sum_{r=o}^{r=m} A_r\,B_0\,B_0^r = 0,$$

it is evident that its *exact* solution is impossible as often as m >4, except in one case, viz.: when $A_0 = 0$, in which we have also $B_0 = 0$. The approximate solution of the above equation by development will be explained in Part II.

§3. In the special case $A_0 = 0$ we have $B_0 = 0$, because $\varkappa$ and *y* are zero at the same time. Consequently we have $\Sigma_\delta = A_\delta$ and the formulas (8) may be written in the form

$$\left.\begin{aligned}
&B_0 = A_0 = 0 \\
&B_1\,A_1 = 1 \\
&B_2\,A_1 + B_1^2\,A_2 = 0 \\
&B_3\,A_1 + 2\,B_1\,B_2\,A_2 + B_1^3\,A_3 = 0 \\
&B_4\,A_1 + 2\,(B_1\,B_3 + \tfrac{1}{2}\,B_2^2)\,A_2 + 3\,B_1^2\,B_2\,A_3 + B_1^4\,A_4 = 0 \\
&B_5\,A_1 + 2\,(B_1\,B_4 + B_2\,B_3)\,A_2 + 3\,(B_1^2\,B_3 + B_2^2\,B_1)\,A_3 + \\
&\qquad 4\,B_1^3\,B_2\,B_4 + B_1^5\,A^5 = 0
\end{aligned}\right\} \quad (8')$$

etc., their solutions being

$$\left.\begin{aligned}
B_1 &= +\frac{1}{A_1} \\
B_2 &= -\frac{1}{A_1^3}A_2 \\
B_3 &= +\frac{1}{A_1^5}(2\,A_2^2 - A_1\,A_3) \\
B_4 &= -\frac{1}{A_1^7}(5\,A_2^3 - 5\,A_1\,A_2\,A_3 + A_1^2\,A_4),\ \text{etc.}
\end{aligned}\right\} \quad (9')$$

PART II.

§4. When A_0 is not zero, the given series may be written in the form

$$\varkappa - A_0 = \sum_{r=1}^{r=m} A_r\,y^r \qquad (10)$$

Here we have exactly the case of §3 and the formulas (9′) will at once give the coefficients of the series

$$y = \sum_{\delta = o}^{\delta = \mu} B_\delta (\varkappa - A_0)^\delta. \tag{10′}$$

§5. When it is required to have y developed into a series of ascending powers of $\varkappa$ itself, we may proceed in the following way. Let the given series be written in two different ways,

$$\varkappa = \sum_{r=o}^{r=m} A_r y^r \text{ and } \varkappa - A_o = \sum_{r=1}^{r=m} A_r y^r,$$

and consequently also the reversed series

$$y = \sum_{\delta = o}^{\delta = \infty} B_\delta \varkappa^\delta \text{ and } y = \sum_{\delta = o}^{\delta = \infty} C_\delta (\varkappa - A_0)^\delta. \tag{11}$$

The values of the C are given by the formulas (9′), provided that we write C instead of B, as has been explained in §4, while the coefficients B are still unknown. Developing $(\varkappa - A_0)^\delta$ by the Newtonian formula, we get

$$(\varkappa - A_0)^\delta = (-1)^\delta \sum_{\lambda = o}^{\lambda = \infty} (-1)^\lambda \binom{\delta}{\lambda} A_0^{\delta - \lambda} \varkappa^\lambda;$$

and equating the two series (11), we obtain

$$\sum_{\delta = o}^{\delta = \infty} B_\delta \varkappa^\delta = \sum_{\lambda = o}^{\lambda = \infty} (-1)^\lambda \varkappa^\lambda \sum_{\delta = o}^{\delta = \infty} (-1)^\delta C_\delta \binom{\delta}{\lambda} A_0^{\delta - \lambda};$$

and finally by the theorem of *Indeterminate Coefficients*,

$$B_\lambda = (-1)^\lambda \sum_{\delta = \lambda}^{\delta = \infty} (-1)^\delta \binom{\delta}{\lambda} C_\delta A_0^{\delta - \lambda} \tag{12}$$

This formula may be transformed, by changing the index $\delta = \lambda + r$, thus:

$$B_\lambda = (-1)^\lambda \sum_{r = o}^{r = \infty} (-1)^{\lambda + r} \binom{\lambda + r}{\lambda} C_{\lambda + r} A_0^r, \tag{12′}$$

where instead of $\binom{\lambda + r}{\lambda}$ we may write $\binom{\lambda + r}{r}$. The *convergence* of the series (12) will depend upon the coefficients C and must be examined in each special case; in general we can state that it always converges, when we have

$$\lim_{a = \infty} \frac{C_{\delta + 1}}{C_\delta} < \pm \frac{1}{A_0}$$

Example.—Let it be required to reverse the series

$$\varkappa = 1 + \tfrac{1}{1} y + \tfrac{1}{2} y^2 + \tfrac{1}{3} y^3 + \cdots$$

Here is $A_\delta = \frac{1}{\delta}$ $(\delta > 0)$ and $A_0 = 1$, hence we obtain from (9′), writing C instead of B,

$$C_0 = 0,\ C_1 = 1,\ C_2 = -\frac{1}{\pi(2)},\ C_3 = +\frac{1}{\pi(3)},\ C^4 = -\frac{1}{\pi(4)}, \text{ etc.,}$$

and in general (except C_0)

$$C_\delta = (-1)^{\delta+1}\frac{1}{\pi(\delta)} \text{ or } C_{\lambda+r} = \frac{(-1)^{\lambda+r+1}}{\pi(\lambda+r)}.$$

This value substituted in (12′) gives for $\lambda > 1$

$$B_\lambda = (-1)^{\lambda+1}\sum_{r+o}^{r+\infty}\binom{\lambda+r}{\lambda}\frac{1}{\pi(\lambda+r)} = \frac{(-1)^{\lambda+1}}{\pi(\lambda)}\sum_{r=o}^{r=\infty}\frac{1}{\pi(r)} =$$

$$\frac{(-1)^{\lambda+1}}{\pi(\lambda)} \times e,$$

and for $\lambda = 0$, since $C_0 = 0$,

$$B_0 = -\sum_{r=1}^{r=\infty}\frac{1}{\pi(r)} = 1 - \sum_{r=o}^{r=\infty}\frac{1}{\pi(r)} = 1 - e\,;$$

where $e = 2.7182818\!28 +$ is the base of, the *Nepierian* system of logarithms.

Substituting these values into the first of the formulas (11) we obtain

$$y = \sum_{\lambda=o}^{\lambda=\infty} B_\lambda \varkappa^\lambda = 1-e+e\sum_{\lambda=1}^{\lambda=\infty}\frac{(-1)^{\lambda+1}}{\pi(\lambda)}\varkappa^\lambda.$$

Consequently the given series

$$\varkappa = 1 + \frac{y}{1} + \frac{y^2}{2} + \frac{y^3}{3} + \frac{y^4}{4} + \ldots = 1 + \sum_{r=1}^{r=\infty}\frac{y^r}{r}$$

is reversed in the following way:

$$y = 1 - e\left(1 - \frac{\varkappa}{1} + \frac{\varkappa^2}{1.2} - \frac{\varkappa^3}{1.2.3} + \frac{\varkappa^4}{1.2.3.4} - \ldots\right)$$

$$= 1 - e\sum_{r=o}^{r=\infty}(-1)^r\frac{\varkappa^r}{\pi(r)}.$$

This last formula may be tested in the following way. The given series requires that we have at the same time $\varkappa = 1$ and $y = 0$, consequently the reversed series requires the identity

$$1 - \frac{1}{1.2} + \frac{1}{1.2.3} - \frac{1}{1.2.3.4} + \ldots = \frac{e-1}{e},$$

which may be verified without difficulty.

Part III.

The equations (10) and (10′) imply the *approximate solution of algebraic equations*. Putting $A_0 = 0$ and assuming for $\varkappa$ any constant quantity, say a, we may write these equations in the following way:

$$a = \sum_{r=1}^{r=m} A_r y^r, \text{ solution, } y = \sum_{\delta=o}^{\delta=\mu} B_\delta a^\delta \qquad (13)$$

The coefficients B are determined by the equations (8) and (9). We do not say (8′) and (9′), because the condition $B_0 = 0$ is not by necessity fulfilled in this case, although we have $A_0 = 0$. While in §1 we have stated that the reversion of the series admits of but one root of the equation (1), since there is but one way of developing y into a series of ascending powers of $\varkappa$, we now have to say, that all the m roots of

the equation (1) are to be considered, since our equation (13) of the *m*th degree admits of *m* solutions. And indeed, equation (13) being no more an identity, we cannot say, as we did in §3, that *a* and *y* will be zero at the same time.

Consequently the condition (1) is be taken in its full extent and, since $A_0 = 0$, may be written this way:

$$\sum_{r=1}^{r=m} A_r B_0^r = 0 \tag{14}$$

This equation is at once resolved into the following two:

$$B_0 = 0 \text{ and } \sum_{r=1}^{r=m} A_r B_0^{r-1} = 0, \tag{14'}$$

thus showing that *the solution of the equation of the mth degree is made dependent on the solution of an equation of the (m — 1)th degree*, as has been remarked also by Prof. Schlömilch on page 26 of his article referred to. For each root B_0 the formulas (7) and (8) will furnish a different set of coefficients B_1 B_2 .... and consequently a different value of *y*, and the formulas (9′) give at once the value of *y* for the root $B_0 = 0$:

$$y = + \frac{1}{A_1} a - \frac{1}{A_1^3} A_2 a^2 + \frac{1}{A_1^5} (2 A_2^2 - A_1 A_3) a^3 - \frac{1}{A_1^7} (5 A_2^3 - 5 A_1 A_2 A_3 + A_1^2 A_4) a^4 + \dots \tag{15}$$

As we have already noted in §2, this method is applicable especially to such series in which the first coefficient A_1 is large in comparison to the following ones.

First example.—Let the given equation be

$$y^2 + 10 y + 1 = 0.$$

Here we have $A_2 = 1$, $A_1 = 10$, $a = -1$, and from (14′) we get the two conditions $B_0 = 0$ and $B_0 = -10$. By the first we obtain from (15)

$$y_1 = -\frac{1}{10} - \frac{1}{10^3} - \frac{2}{10^5} - \frac{5}{10^7} - \dots = -.1010205 \dots.$$

By the second condition $B_0 = -10$, we compute from (7)

$$\Sigma_1 = -10,\ \Sigma_2 = 1,\ \Sigma_3 = 0, \text{ etc.};$$

and by means of these values from (8) or (9)

$$B_1 = -\frac{1}{10},\ B_2 = \frac{1}{10^3},\ B_3 = -\frac{2}{10^5},\ B_4 = \frac{5}{10^7}, \text{ etc.};$$

and finally we have from (13)

$$y_2 = -10 + \frac{1}{10} - \frac{1}{10^3} + \frac{2}{10^5} - \frac{5}{10^7} + \dots = -9.8989795 \dots$$

A proof of this calculation is found in that $y_1 + y_2$ is equal to the negative cofficient of *y*.

Second example.—Let it be required to solve the equation of the fourth degree

$$y^4 - 4 y^3 - 25 y^2 + 100 y + 1 = 0.$$

Here we have $A_4 = 1$, $A_3 = -4$, $A_2 = -25$, $A_1 = 100$, $a = -1$.

The equations (14) are now

$$B_0 = 0 \text{ and } B_0^3 - 4 B_0^2 - 25 B_0 + 100 = 0.$$

The latter admits of being resolved in the following way:

$$B_0^4 - 4 B_0^3 - 25 B_0 + 100 = (B_0^2 - 25)(B_0 - 4),$$

and thus we obtain for B_0 the following numerical values 0, —5, +4, +5.

1. By the first we obtain from (15)

$$y_1 = -\frac{1}{100} + \frac{25}{100^3} - \frac{1650}{100^5} + \frac{118125}{100^7} - \ldots$$
$$= - .009,975,163,8 \ldots$$

2. By the second we compute from (7)

$$\Sigma_1 = -450,\ \Sigma_2 = +185,\ \Sigma_3 = -24,\ \Sigma_4 = 1,\ \Sigma_5 = 0, \text{ etc.},$$

and consequently from (8) or (9)

$$B_1 = -\frac{1}{450},\ B_2 = +\frac{185}{450^3},\ B_3 = -\frac{57650}{450^5}, \text{ etc.},$$

and finally from (13)

$$y_2 = -5 + \frac{1}{450} + \frac{185}{450^3} + \frac{57650}{450^5} + \ldots$$
$$= -4.997,775,744,5 \ldots$$

3. In the third case $B_0 = +4$ we find from (7)

$$\Sigma_1 = -36,\ \Sigma_2 = +23,\ \Sigma_3 = +12,\ \Sigma_4 = 1,\ \Sigma_5 = 0, \text{ etc.},$$

and from (9)

$$B_1 = -\frac{1}{36},\ B_2 = \frac{23}{36^3},\ B_3 = -\frac{1490}{36^5},\ B_4 = \frac{80707}{36^7}, \text{ etc.};$$

hence from (13)

$$y_3 = 4 + \frac{1}{36} + \frac{23}{36^3} + \frac{1490}{36^5} + \frac{80707}{36^7} + \ldots$$
$$= 4.028,296,8 \ldots.$$

4. In the fourth case $B_0 = +5$ we have from (7)

$$\Sigma_1 = +50,\ \Sigma_2 = +65,\ \Sigma_3 = +16,\ \Sigma_4 = 1,\ \Sigma_5 = 0, \text{ etc.},$$

and from (9)

$$B_1 = \frac{1}{50},\ B_2 = -\frac{65}{50^3},\ B_3 = \frac{7650}{50^5},\ B_4 = -\frac{1115625}{50^7}, \text{ etc.};$$

consequently:

$$y_4 = 5 - \frac{1}{50} - \frac{65}{50^3} - \frac{7650}{50^5} - \frac{1115625}{50^7} - \ldots$$
$$= +4.979,453,9 \ldots$$

A proof of the work is found in the sum of the four roots,

$$\begin{aligned} y_1 &= -0.009,975,163,8 \\ y_2 &= -4.997,775,744,5 \\ y_3 &= +4.028,296,8 \\ y_4 &= +4.979,453,9 \\ \hline &\ \ +4.000,000, \end{aligned}$$

inclusive of the sixth decimal place being equal to the negative coefficient of y^3.

On the Conversion of Chlorine into Hydrochloric Acid, as observed in the Deposition of Gold from its Solutions by Charcoal. By Wm. Morris Davis.

(Read before the American Philosophical Society, April 6, 1883.)

The simple fact of such conversion, while of interest in a chemical point of view, would not justify me in occupying the time of this meeting in discussing it.

But in its technical application to the cheap and effective deposition of gold from its solution, both from the novelty and usefulness of the method it is deemed worthy of your attention.

Preliminary to the description of the process, and necessary to an appreciation of its value in a technical sense, the following facts have an important bearing.

It has been estimated that only about one-tenth of the gold of our country exists in an uncombined state (as free milling ores), or as dust and grains of gold in river sands, or placer washings; such gold is largely obtained by amalgamation processes.

The remaining nine-tenths is found in veins of the older geologic period, and is held in combination by sulphides, arsenides and tellurides; to these ores the process of amalgamation with mercury has been found inapplicable; hence they are generally known as refractory ores.

Two methods have been adopted for working these refractory ores, viz.: Smelting or fusion with lead, and chlorination; that is by first reducing the combined sulphides, &c., to oxides, and then dissolving the gold by means of chlorine.

The process of smelting is applicable to refractory ores only, when they carry a high value in gold, because of the high cost attending the method. Crooks and Röhrig's "Metallurgy" teaches that "ores containing combined gold to the amount at $20 per ton cannot be profitably fused with lead; even could they be raised without mining cost." As a rule in this country this process is not applied on ores below the value of $40 per ton.

By chlorination, ores carrying $20 per ton, can be profitably worked, mining costs included.

Without entering into the question of chlorination, it may be remarked that various methods have been devised whereby the solvent powers of chlorine have been applied to the extraction of gold from such ores. The process is an old one, is one which has been long in use, and the excellence of the method is admitted; it has been found that the solvent power of a chlorine solution is much increased by operating with the gas under a pressure equal to two or more atmospheres.

By such proceeding it is evident that the chlorine solution employed in the chlorinating apparatus will be highly saturated with the gas; it was with such supercharged solutions that the following experiments with carbon were conducted. It is taught that water at ordinary temperatures will

hold in solution two and a half times its volume of chlorine, and that five cubic feet of the gas will weigh one pound, and it has been found in practice that under the Mears' system or method, by pressure, the resultant solution carried such volume of gas as to require an excessive amount of sulphate of iron, or sulphuretted hydrogen (where these precipitants are used) to neutralize the excess of chlorine, before they could act in precipitation of the gold. Thus adding a cost that our low grade ores will not bear; other difficulties and shortcomings, attend the precipitations by these reagents, not necessary to describe, as they are well known to all who have adventured on any of the various modes of chlorination, and which are clearly set forth in Crook and Röhrig's "Metallurgy," in describing Plattner's Chlorinating works at Richenstein, upper Silesia.

From the unsatisfactory results of thus precipitating the gold after it is obtained in solution, chlorination processes have been of limited application, being mainly confined to operations on a small scale and to the concentrated tailings of other processes.

In the effort to overcome these obstacles to success, and to adapt chlorination to the requirements of enlarged operations, the writer reached results which are herein described and explained.

In an aqueous terchloride, or normal solution of chloride of gold, very many substances, both inorganic and organic, will decompose the salt and precipitate the gold in a metallic state, or in combination with the substances employed; but excepting the proto-sulphate of iron, or sulphuretted hydrogen, they are quite inapplicable in a solution surcharged with chlorine, especially is this the case, in the use of organic substances, owing in a measure to their rapid decomposition and disintegration by chlorine.

In vegetable charcoal we find an organic structure capable of resisting the destructive influences of chlorine, therefore, after numerous failures with other organic substances, this was adopted as subject of experiment; and it was found possessed of a remarkable power in decomposing the auric solution, converting the chlorine rapidly into ClH, depositing the gold upon, and throughout the charcoal, and allowing contained copper to pass off in the escaping fluid. Thus, by a simple regulated flow through charcoal, surmounting the sole difficulty to the employment of the chlorine process, on an extended scale of operations.

The gold was retained in metallic form, and of great purity; by long continued action the gold was observed to replace the wasting carbon, atom for atom, fibre for fibre, retaining the form and structure of the fragment of coal, so that on the dissipation of the carbon by incineration, and washing away the ash by SO^3, a brilliant and perfect golden pseudomorph of the coal was obtained.

The copper in the solution was not affected by the coal, and it passed to its appropiate tank to be precipitated by iron as cement copper.

In a report made by Prof. F. M. Endlich, to parties in New York, he says, "In order to test the efficacy of the process, I took, systematically,

samples from the receiving tanks, from the collecting tanks, from the pipe which carried the solution to the filter, and from the stop cock through which the liquid passed after the solution had been in contact with the charcoal.

"The unvarying results of these repeated tests may be summed up briefly:

"While I never failed to get copious precipitates of gold from the solution in the tanks, and from that taken from the faucet through which it flowed into the filter, I never obtained the slightest gold precipitate from *the same liquid after it had passed through the charcoal.*

"The tests which were employed to detect gold in the liquid which had passed through the charcoal were varied, and entirely sufficient to be convincing. Sulphate of iron will decidedly indicate the presence of one part of gold to forty thousand parts of liquid.

"Neither with this reagent, nor with any others that were used could a trace of gold be detected in the liquid taken from the lower spigot of the first barrel, containing one hundred pounds of charcoal, measuring twenty-eight inches vertically, after about nine hundred and sixty gallons of terchloride solution had passed through it."

This amount of solution represented about six thousand pounds of ore, carrying according to assays, $72 in gold.

He continues, "Briefly restating what has been said at greater length, I would repeat that the charcoal filter as here used, is entirely sufficient to precipitate from a terchloride solution, *all the gold* contained therein."

Prof. Endlich remarked on the disappearance of the chlorine from the solution after it had passed the filter. At this stage of the experiment the true cause of the deposition of the gold was not determined, on this point he writes:

"As to the chemical exchanges which take place, and produce the result, I cannot speak positively, and have not, at present, the time at my command to make the requisite investigations."*

It was not until operations were conducted on an enlarged scale that we arrived at an explanation of the reactions which occur in the contact of the terchloride solution with carbon.

It was known to a few antiquarian delvers in chemical records, that among the multitude of substances which decompose a solution of chloride of gold, carbon was named by Count Rumford as possessing this property, but it was only under certain conditions that he observed it to act, for he says, "recently ignited charcoal separates gold, only in sunshine or at 109°;" further experiment proved that under the influence of light, or heat, gold will separate from its solution in the absence of charcoal.

Thus Kane teaches that, "when chlorine water is exposed to the light, it is gradually decomposed, chloride of hydrogen being formed, and

*Prof. E. subsequently writes: "Your conclusions regarding the decomposition of water for the formation of ClH seem a little forced."

oxygen being set free, he further states that heat has the effect of decomposing such solution with the same results;" should gold be present, it will be precipitated in proportion to the disappearance of free chlorine.*

When it thus appeared that the recited conditions alone were sufficient for the deposition of gold from its solution, then was Rumford's discovery consigned to the limbus of useless speculations. This remarkable property of carbon is casually mentioned by a few authors; but it is nowhere taught that carbon is distinguished by any remarkable energy, or as differing from the crowd of organic substances with which it was classed.

Neither is it anywhere suggested that such deposition was of any commercial value, and no use has ever before been made in the metallurgic separation of gold from its solution, nor has carbon been employed in obtaining gold from its ores except as a fuel.

Just the opposite has been the case, for when the attention of experts was called to the claims of this process, they generally agreed that there was nothing in chemical laws or scientific principles to sustain the assumption, and at this moment well informed minds are at a loss to account for the remarkable energy of this new agent in reducing gold from a solution to a metallic state, and the additional fact, that it is inert towards other earthy and metallic constituents of the solution. Thus serving as a refining agent also.

As sustaining the claim of *novelty*, for the hypothesis of the conversion of chlorine into ClH, by carbon, allusion may be made to the contrary opinion of many chemists, as expressed in correspondence with the writer. Several incline to the opinion that the reduction is simply a mechanical attraction of the carbon for the gold (corresponding to the action of animal carbon on the impurities in sugar); this opinion has been held regardless of the disappearance of large volumes of chlorine, and the formation of its equivalent of ClH.

Others ascribe the action to the defective carbonization of the wood, and seek explanation in the "oils, resins, or partially changed wood fibre," which are known to precipitate gold.

Some claim that the action is due to the presence of hydrogen in the gaseous ammonia, which charcoal absorbs with avidity from the air. If such were the case, the action would be of short duration in the presence of highly charged chlorine solutions; but, that such is not the case, may be experimentally shown, by submitting a perfectly prepared piece of charcoal to a high heat, and, while in a state of ignition, quenching it in distilled water (simply for the purpose of cooling), then immediately transfer it in the dark to a cold surcharged chlorine solution carrying gold and copper; the effect will be the disappearance of the free chlorine, the

* In the quantitative investigation of this subject by Dr. G. A. Kœnig of the Pennsylvania University, as published in Journal of Franklin Institute, May 8, 1882, this property of heat, to decompose a gold solution was overlooked, and his conclusions are invalidated by his employing heat in the digestion of the carbon in the gold solution.

presence of its due equivalent of ClH, the deposition of the gold on the carbon, while the copper will be found in the solution. That the action of carbon in effecting such changes is not evanescent has been shown, but may be repeated in brief:

A filter containing one hundred and sixty pounds of charcoal in the operations of the mill, after a continuous flow of chlorine solution for ten days, and passing sixteen thousand gallons (representing eighty tons of ore) was still effective in producing the above results. Some few writers in their hasty experiments failed in getting satisfactory results and dismissed the subject as "the wild dream of a mad inventor."

The following formula is offered as explanatory of the reactions attending the deposition of gold from its solution by charcoal:

2 $AuCl^3$....	Au^2	2 Au free.
	Cl^6	
3 Carbon...	C^3	
6 Aqua	H^6	6 ClH
	O^6	3 CO^2

Chemistry teaches that "Chlorine has a powerful affinity for hydrogen, and when brought in contact with other bodies, in the presence of water, will decompose the water by combining with the hydrogen forming ClH and liberating oxygen. Thus, substances are frequently oxidized by chlorine to a higher degree than by nitric acid. Kane teaches that

"Selenious acid (SeO^2) and chlorine in the presence of water is converted into selenic acid (SeO^3) and hydrochloric acid (ClH).

$$SeO^2 + Cl + HO = SeO^3 + ClH."$$

Reasoning from analogy, we may explain the reactions in the deposition of gold: by substituting carbon for selenious acid in this formula; in which case the carbon is oxidized at the expense of the water, the hydrogen uniting with the chlorine to form ClH.

That such are the reactions may be assumed, *a priori*, as all the elements involved are satisfied according to their equivalent affinities, and form definite compounds, leaving the gold free; and it follows, that the deposition of the gold is occasioned by the conversion of the chlorine (which is a solvent of the metal) into chlorohydric acid (in which gold is insoluble), and it is in nowise owing to an attraction or affinity of carbon for gold.

As copper is soluble in muriatic acid it is not affected by the change in

the condition of the chlorine, from a free to a combined state, and this metal remains in solution, as does every contained substance, which is soluble in ClH.

That the free chlorine is thus converted into the combined state is shown by the following experiment, which was made after the carbon had converted two hundred times its volume of chlorine, or the filter of 80 gallons of coal had received 8750 gallons of the chlorine solution, carrying about twice its volume of gas :

Of the running solution two samples were taken, one from the surface before it entered the coal, the other from the bottom after it had passed through the filter; from the first, the chlorine acted powerfully on the senses ; in the second, no odor was perceptible.

To equal portions of the two samples were added nitrate of silver, the precipitated chloride was collected, washed and dried with due precautions, and the weights of the two precipitates exactly corresponded ; the one measuring the sensible, the other the combined chlorine.

In only one experiment of long-continued action, has a sensible diminution of the carbon been observed ; further and more exact determinations than could be made in a mine laboratory are required to establish this point.

Neither has it been determined to what extent the deposit of gold can be carried by this method, the button of gold now exhibited weighing eighteen and a half pennyweights was recovered from the ash of two ounces of charcoal ; the filter from which it was taken seemed to have lost none of its activity. The grains from the surface of this filter yielded the pseudomorphs of gold which are before you, and the weight of the gold is above one-third the weight of carbon, which has been removed.

As affecting this question, and possibly of interest to the chemist, the following observation was made on the action of dilute SO^3 on charcoal taken from a filter after being subjected to the action of chlorine for six days :

With the thought that washing this carbon with dilute SO^3 might clean the coal and increase its activity, a portion of it was placed in a glass percolating tube, and the above acid passed slowly through it. The solution from the bottom came away of a dark brown color, but retaining its transparency ; on passing this through filtering paper no deposit was retained, showing that the color was not owing to dust of the coal. The solvent action of the acid continued as long as it was applied, and until the size of the carbon grains were sensibly diminished, when the acid solution was replaced by a current of cold water. Now the escaping fluid was almost black, being many shades darker than the acid solution. This when largely diluted was of a rich brown color, and perfectly transparent. The carbon grains were rapidly diminishing in size, and seemingly entirely soluble, when the process was interrupted to test the power of the remaining contents of the tube on an auric chlorine solution.

On passing such solution through the residuum, it was found to have

lost all power in converting the chlorine or depositing the gold. Although the coal in the large filter from which this portion was taken, retained its full power for three succeeding days, and, so far as the eye could judge its character as a charcoal, remained unchanged; whilst the portion subjected to SO^3 had lost all characteristics of charcoal in qualities and appearance. Pressing occupations interfered with a further examination of this method of reducing charcoal to a soluble condition. This is presented as a new and interesting feature in the history of chlorine.

From notes of a laboratory experiment in a qualitative examination, the following details are given as illustrative of the methods employed to arrive at reliable results. The novelty of the subject and the importance of the conclusions, are offered as apology for the minuteness of detail:

A glass percolator, 18 inches deep, was filled with granular wood charcoal, without other preparation than expelling enclosed gases, and removing adhering substances by immersion in water; a gum tube and compressor at the outlet served to regulate the flow; twenty-four ounces of coal were employed; 100 gallons of solution were used, carrying chlorine that was evident to the senses in escaping fumes; inhalation could not be made at the surface of the coal. This represented 750 pounds of an ore assaying $15.65 gold to the ton. Temperature of the room about 75° F., density of the liquid 3.75 Beaumé; the rate of flow was regulated to one gallon per hour, and continued uninterrupted until the close of the experiment, or 100 hours.

At intervals of an hour samples of the escaping fluid were taken, and tested for gold with sulphate of iron, in every instance it failed to detect gold.

The rich blue color of the escaping liquid showed the presence of copper; remembering that the presence of copper had hitherto impaired the action of sulphate of iron as a precipitant, it remained to be shown that the want of precipitate in the test tubes was a reliable indication of the absence of gold; to test this, every tenth gallon of the filtrate was subjected to the following treatment:

The copper was precipitated by clean iron wire, the resulting cement copper washed on a filter, then dissolved by SO^3, and the undissolved portions secured on a filter, dried, and incinerated, and the ash assayed for gold; the return of which was .01 grain. Now as one gallon represented the $\frac{1}{266}$ part of a ton of ore, the above result shows a loss by reason of the presence of copper of 2.66 grains of gold per ton = 11¼ cts.

At the conclusion of the flow, the charcoal was washed, carefully incinerated in an iron dish, and the ash smelted with borax. The button of gold weighed 139 grains, as the return from 750 lbs. of ore; which is equal to 371 grs. @ 4¼ cts............................$15.77 per ton.

Assay value of the ore .... 15.65 " "

A difference of 12 cents per ton in favor of the finer determinations of analysis by solution, over the approximative method of smelting by fire assay.

Working on a larger scale, the following result was arrived at, in the chlorination works near Salisbury, N. C.:

1963 tons worked; average assay..................$6.11	=	$11,994.19
Net returns fron U. S. Mint......................gold	=	11,158.82
		$835.37

Which shows a loss in working equal 43 cents per ton.

By careful and constant assays of the spent sands, this loss is accounted for, by the washing in the leaching tanks being arrested before the last traces of gold were removed. To thoroughly wash these sands would require a large volume of water, and the loss is regarded as an economic waste.

On this point Dr. Jno. F. Boynton, in a report on an experimental test of the process, reports:

"The spent ores, or tailings, as found in the leaching vats after washing, were subjected to rigid examination; samples were taken of each charge, and careful fire assays made, and in no case did an ounce assay afford gold equal to the one-thousandth part of a grain."

Without entering into the technical details or the costs of manipulation, the above results are presented as evidence that the refractory ores of gold may be worked on an enlarged scale by the joint chlorine and carbon processes, and may in the end utilize the vast stores of these ores, which lie useless in our Southern and Western gold fields.

Stated Meeting, May 4, 1883.

Present, 13 members.

President, Mr. Fraley, in the Chair.

Letters accepting membership were received from Prof. Heilprin, dated Academy Natural Sciences, Philadelphia, April 4; Mr. A. E. Lehman, dated 907 Walnut street, Philadelphia, April 30, 1883; Mr. Philip C. Garrett, dated Fairfield, Germantown, Philadelphia, May 3, 1883, and Mr. Dillwyn Parrish, dated Philadelphia, May 5, 1883.

Letters of acknowledgment were received from the Verein für Erdkunde, at Dresden (108); and the Accademia dei Lincei at Rome (109, 110, 111).

Letters of envoy were received from the Geological Survey of India, Calcutta, Nov. 3, 1882; the Royal Saxon Society, Dec. 11, 1882; the Royal Leop. Car. Deutschen Akademie, Halle, Dec. 7, 1882; the Royal Akademie der Wiss. at Vienna, Dec. 21, 1882; and the Société d'Agriculture at Lyons, (1 to 109), requesting lacking numbers of the Proceedings, which, however, this Society can no longer supply, their edition being exhausted, viz., Nos. 5, 17, 21, 23, 26, 29, 30, 31, 34, 63 and 64.

A letter requesting exchange of publications was received from the Cincinnati Society of Natural History, 108 Broadway, Cincinnati, April 27. On motion it was placed on the list of corresponding societies to receive the Proceedings.

Donations for the Library were received from the Academies at Halle an d. S., Vienna, Buda-Pest, Dijon, and Brussels; the Societies at Görlitz, Göttingen and Lyons; the Royal Saxon and Jablonowski Societies at Leipsig; the German Apothecaries' Union at Halle; the Royal Lombard Institute; the Musée Guimet; the Ethnographical Institute, Zoölogical Society, Geographical Society, Polytechnic School, Mining Bureau and N. H. Museum at Paris; the Com. Geographical Society at Bordeaux; the Revista Euskara; the Royal Astronomical and Asiatic Societies, Society of Arts, and London Nature; Mr. C. Piazzi Smyth of Edinburgh; Mr. Ed. C. Pickering of Boston; the American Antiquarian Society; American Journal of Science; New York Academy of Sciences; Dr. Daniel Draper; Mr. Thomas Dudley; the Franklin Institute, Numismatic and Antiquarian Society, and Mr. Henry Phillips, Jr., of Philadelphia; the American Chemical Journal and American Journal of Mathematics; United States Naval Observatory; United States National Museum; Bureau of Education; Cincinnati Society of Natural History; Davenport Academy; Mr. Horatio Hale; and the Mexican National Museum.

Mr. Henry Phillips, Jr., communicated "A brief account of the more important collections of American Archæology in the United States."

Dr. Frazer read extracts from a letter from M. Daubrée of Paris requesting information on the subject of subterranean waters in the United States; and from his correspondence with Mr. Selwyn of Montreal, Prof. Fontaine and Prof. Winchell, endorsing his views of the prepalæozoic age of the South Valley hill rock.

Pending nominations Nos. 985, 986, were read.

The Treasurer was authorized to receive City Loan maturing July 1, 1883, and the meeting was adjourned.

A Brief Account of the more important Public Collections of American Archæology in the United States. By Henry Phillips, Jr.

(Read before the American Philosophical Society, May 4, 1883.)

To the student of American Archæology it is a matter of the greatest importance to know where in his own land there can be found public collections that will show him the advances made in the arts of war and peace by the aboriginal inhabitants of this Continent. In Europe there exist several of such exhibitions which are noteworthy and famous, where prehistoric America can be studied with great fullness of detail; in the United States there also are rich and valuable public cabinets of American archæology, laboriously and carefully got together, offering a vast field to the seeker after Truth. As to *private* collections, their name is Legion. With a view to diffusing a more general acquaintance with these collections, I prepared a series of queries which I transmitted to every public institution where I had reason to believe there existed such a cabinet, and from the answers received, I have framed the following short account, bringing together matter never before presented at one view.*

ACADEMY OF NATURAL SCIENCES, *of Philadelphia.*

There are five collections of American Archæology at present in the custody of this museum, which, with the exception of the Haldeman collection of arrow-points, stone axes, celts, banner stones, &c., are arranged geographically, and the locality given where each specimen was found. The col-

*No notice has been taken in the following pages of any matter which may relate to collections of *foreign* archæology in the United States; it simply mentions the *American* portion of the cabinets.

lections, having lately been placed in another apartment, are in process of rearrangement, which is taking place under the care of Mr. H. T. Cresson, a well-known and careful student of American archæology.

The collections are as follows:

1. The Poinsett collection of Mexican antiquities, the property of the American Philosophical Society, and deposited by it in the custody of the Academy. It numbers about 2800 specimens, consisting of terra-cottas, objects of obsidian, gold and silver, beads, sculptures, manuscripts, &c., &c. This very fine collection is unique in the United States.

2. The Haldeman collection (about 10,000 specimens), presented by Prof. S. S. Haldeman and wife, in 1879.

3. The Ruschenberger collection of ancient Peruvian pottery (about 200 specimens), presented by Dr. W. W. Ruschenberger, formerly President of the Academy.

4. The Peale collection (about 1800 specimens), formed by Franklin Peale, Esq., and presented to the Academy by his widow.

5. The Vaux collection (about 900 specimens), bequeathed by Wm. S. Vaux, Esq., in 1882.

The especial features are the pottery in the Ruschenberger, Poinsett and Haldeman collections; the valuable and important Poinsett collection as a whole; and a large collection of axes (stone), arrow-points, &c., embracing many rare forms, from all parts of the United States.

American Philosophical Society, *Philadelphia.*

The valuable collections of this Society are deposited with the Academy of Natural Sciences in Philadelphia, and displayed with its cabinets.

Archæological Institute of America, *Boston, Mass.*

This institution "deposits its collections in existing institutions."

American Antiquarian Society, *Worcester, Mass.*

This cabinet was founded in 1812. Its collections, which although not numerous are valuable, consist of stone implements and mound relics, whose number has not been furnished. It is only partially arranged, catalogued and labeled, and the localities where the specimens were found are not always given.

Amherst College, *Amherst, Mass.*

This collection is about forty years old, and is mainly comprised of specimens found in the valley of the Connecticut river, within fifty miles of the town. The best specimens, some twenty-five hundred, are entered in the catalogue, an outline of each one being drawn. They are properly labeled, and the locality given where each was found. The especial features of the collection are samples of all the pottery supposed to be of New England aboriginal manufacture. It is also rich in Indian pipes.

BROWN UNIVERSITY, *Providence, R. I.*

This cabinet was begun in 1872. The specimens, which are numerous but whose exact number is not known, are arranged for the present typically. In most cases they are labeled with the name of the place where found.

DAVENPORT ACADEMY OF NATURAL SCIENCES, *Davenport, Iowa.*

This cabinet was formed during the last ten years from finds in the vicinity of fifty miles of the city. The pottery is mostly from the mounds of the Lower Mississippi valley; the shell ornaments and bone implements are also mainly from thence; the stone and flint implements from Wisconsin to the Gulf of Mexico, and from Florida to Colorado. It is classified chiefly typically. It possesses inscribed tablets found at Davenport, carved stone pipes, typical of the Upper Mississippi, *i. e.* of the "curved base" pattern, of which there are 57. This is the largest collection of this type in the United States.

Of other patterns of prehistoric pipes there are	30
Hammered copper axes	28
" " awls	16
" " beads	300
" " knives, &c	5

Prehistoric pottery vessels over 1000, some of them the largest ever found in North America:

Flint implements over	10,000
Stone " "	1000
Hæmatite " "	52
Obsidian points	25
Shell and pearl beads several hundred.	
Gorgets and other shell ornaments	70
Bone implements mostly awls	120

Perforated ceremonial stones, &c., 21; skulls of northern mound-builders, 35; skulls of southern mound-builders, 33; skulls of Sioux Indians, 307; skulls of Central American, 127, &c.

The collection which is in process of catalogueing, is displayed in glass cases in such a manner as to be readily accessible.

The localities are given in the labels, together with many other details, "so that the whole explains itself to the visitor" writes Mr. W. H. Pratt, who kindly furnished the data for the foregoing account.

GEORGIA HISTORICAL SOCIETY, *Savannah, Ga.*

The collections of this Society were begun in 1839, but, not being very extensive, are not arranged in a strictly scientific manner. The specimens which are labeled, and on exhibition in the Society's Hall, are not catalogued.

METROPOLITAN MUSEUM OF ART, *New York City, N. Y.*

This collection (which is not large) consists of Mexican, Peruvian and Central American antiquities, and of mound-builder's pottery, all acquired since 1880, and numbers about 200 pieces. It is classified geographically. Among the noteworthy features of the collection are a remarkable Aztec pot and some pieces of Peruvian metal work. The Mexican terra-cottas are also worthy of remark. A catalogue is now in press in which the localities are given of each specimen so far as known.

MAYSVILLE AND MASON COUNTY HISTORICAL AND SCIENTIFIC ASSOCIATION, *Maysville, Ky.*

The collections of this Society were begun in 1875, their object being to illustrate the various implements used by the mound-builders of the Ohio Valley. The specimens were mostly found within a radius of fifteen miles of the town. The collections are not fully catalogued and arranged, but among the more noteworthy are a hæmatite skin-dresser, one leaden implement, two inscribed stones, eight discoidal stones, five boat-shaped stone images, twenty-two stone maize-beaters, thirty-two ground-stone hatchets, one stone image of a sheep or llama (head and half the body), ninety-two skin-dressers, sixty-two hammer-stones, six chert-choppers, two flint-choppers, three flint (burial) stones, seventeen slate ceremonial implements, two and one-half round sinkers, eleven stone sinkers, one stone plummet, two stone chisels, one stone roller, fifty-two flint drills, six hundred arrow and spear-points, eighty-seven war arrow-points, seventy flint knives, sixty-five scrapers, thirteen flint skin-dressers, one flint gouge.

MINNESOTA HISTORICAL SOCIETY, *St. Paul, Minn.*

The fine museum of this Society was destroyed by the fire of March 1, 1881. It now only possesses two stone hammers and a copper chisel.

MISSOURI HISTORICAL SOCIETY, *St. Louis, Mo.*

The collections of this Society are as yet in their infancy, and not catalogued and arranged.

NEW LONDON COUNTY HISTORICAL SOCIETY, *New London, Conn.*

This collection being of recent origin, has not yet been entirely arranged, classified, labeled, and catalogued. The specimens number about 2500.

THE NATIONAL MUSEUM, *Washington, D. C.*

This collection was established in 1842, its possessions then consisting of the specimens obtained during the Wilkes' Exploring Expedition. In 1858 it passed into the care of the Smithsonian Institution. The general collection is arranged typically; special collections from mounds, shell-heaps, &c., are kept together. At present it contains about 20,000 chipped implements, arrow-heads, &c.; about 3000 hammer stones, celts, pestles,

grooved axes, pipes, ornaments, &c.; about 800 objects of shell, beads, &c.; about 600 bronze implements and ornaments; about 600 shell-heap remains; about 700 mound remains; and about 300 cave remains. It is catalogued and the locality given where each specimen was found. "It is considered the largest existing collection of *North American* antiquities," writes Professor Baird. The display is made in sixty-two glass cases, in a hall 200 feet long by 50 wide.

PEABODY MUSEUM OF AMERICAN ARCHÆOLOGY AND ETHNOLOGY, *Cambridge, Mass.*

The Museum was founded by the gift of $160,000 by Mr. George Peabody, in 1866.

The Museum has made a number of special explorations from which large returns have come, among which may be mentioned the exploration by Prof. Hartt in Brazil, those by Dr. Flint in Central America, and the many special explorations in North America, including those of Dr. Palmer in various parts of Mexico, and among the Indians of the Southwest; of Miss Fletcher among the Indians of the West; of the late Dr. J. Wyman (the first curator) in Florida and along the Atlantic coast, of Dr. Schumacher on the coast of California; Mr. H. Gilman in Michigan, of Prof. Andrews in Ohio, Mr. Dunning in Tennessee, Dr. Abbott in New Jersey, Dr. Metz in Ohio, Mr. Curtis in Tennessee and Arkansas, and the explorations of Prof. Putnam in various parts of the country, particularly of New England shell-heaps, of mounds and ancient burial places in the Western and Southwestern States, of caves in Kentucky, etc., etc.

"The Museum" writes Prof. F. W. Putnam, its curator, "contains by far the most important collections in existence relating to the archæology of America as a whole. (In ethnological material it is not so well off, but it contains pretty large collections of that.) The arrangement of the collections is based upon a geographical distribution of the materials in the several exhibition halls, but it is made to embrace an ethnological and archæological presentation of the subject. Every specimen in the Museum (over 300,000) is catalogued and numbered, and unless the exact locality and conditions under which a specimen was found is known, it is considered as worthless for exhibition, and of no value to an archæological or ethnological series."

PEABODY ACADEMY OF SCIENCE, *Salem, Mass.*

This collection is composed of those of the East India Marine Society (begun in 1799), and of the Essex Institute (1826), which in 1867 were permanently placed in the East India Marine Hall, purchased and refitted by the Trustees of the Peabody Academy of Science in that year.

The Department of American Archæology contains 2390 catalogue numbers, in all about 5500 specimens; axes, 100; celts, 150; gouges, 150; club-heads, 50; hammer-stones, 50; long stones (pestles), 100; discs, 10; spear-points, 500; arrow-points, 2000; scrapers, 200; bones

from shell-heaps, a half bushel; bone implements, 50; grave contents, 25 skulls, and long bones and numerous implements, shell beads, &c.; copper implements, 2; soapstone pots, 3; broken pottery (soapstone), 50; clay pots, 5; broken clay pottery, 500; core stones and rude implements, 500; chips, a bushel; mortars and mills, 6; ceremonical objects, 50; shoes, &c., (salt cave, Kentucky,) 20; implements showing contact with European civilization, 50; bone spoons from graves, 4; knives, of various shapes; piercing tools, 10. The bulk of the collection is from the Eastern portion of the United States, very few being from south of Pennsylvania or west of New York State. They are arranged by types according to the order of Abbott's primitive industry, and the special features of the collection are the specimens figured in that work. All are labeled. The "archæology of Essex County, Mass.," is arranged separately, and made an especial feature of the Museum. It is in a case seven feet high and forty feet long. Independent of the usual assortment of axes, celts, gouges, &c.; it contains one very fine skeleton intact from a reburial at Marblehead, Mass., and a number of grave contents, such as beads, wampum and bones, &c.: also articles from shell-heaps, and the entire valuable contents of one shell-heap opened in 1882. The general appearance of these implements is rude as compared with those from the Western States, and the finds are but scanty in comparison.

Especial attention is called to the manner in which the specimens are fastened, so that placed in upright cases, every kind of article may be placed. Bent headless pins are used to clamp the objects on black tablets which are placed on easels and in the cases.

"The Museum is one of the first-class," writes Mr. John Robinson, Treasurer and temporary Curator, who has kindly furnished the data for the foregoing account.

PHILADELPHIA. THE NUMISMATIC AND ANTIQUARIAN SOCIETY OF

This collection was begun in January, 1858. It is at present undergoing rearrangement and classification, by Mr. Edwin A. Barber, Curator of Antiquities, so that no exact details can be given, but it is believed that by the end of the present year it will be in perfect order; before which time also the Society expects to receive some remarkable American antiquities, almost unique in this country.

PENNSYLVANIA MUSEUM AND SCHOOL OF INDUSTRIAL ART, *Memorial Hall, Fairmount Park, Philadelphia.*

This institution possesses a small but valuable collection of Peruvian, Pueblo and other American pottery. A large collection of American archæology at present on exhibition will probably shortly be removed on account of the death of the owner.

POLYTECHNIC SOCIETY, *of Louisville, Kentucky.*

This Society "possesses some rare and valuable archæological specimens," but they are neither catalogued, classified nor arranged. "Among the more important," writes Mr. E. A. Grant, "is a copper spool found in a mound, much oxidized, but still having the remains of fibrous cord imbedded in the copper, so that the same can be removed."

RHODE ISLAND HISTORICAL SOCIETY, *Providence, R. I.*

The collection was begun in 1822. It is not at present fully classified; the localities of the specimens are not always given; their number is unknown. Mr. Perry, the Secretary of the Society, writes, "Our Indian relics need a thorough overhauling."

TENNESSEE HISTORICAL SOCIETY, *Nashville, Tenn.*

In its cabinets are many objects of American archæology (number not given), including Pueblo manufactures, stone images, arrow-heads, fleshers, discs, &c., &c. Some are on exhibition in the State Capitol, and the Society expects to soon occupy a new hall, where its large and valuable collection will be properly arranged and displayed.

UNIVERSITY OF MICHIGAN, *Ann Arbor, Michigan.*

This collection has "never been classified or catalogued. It is in process of removal to a special room where it will be arranged geographically." The number of its specimens is not known. Among the most noticeable are Peruvian pottery, and Alaskan implements, &c.

WISCONSIN NATURAL HISTORY SOCIETY, *Milwaukee, Wis.*

This collection has not yet been fully classified nor catalogued, nor are the specimens all labeled, but it is expected that before long it will be properly arranged and put in complete order. "It contains" writes Mr. Carl Dœrflinger, the Secretary and Custodian, "some 2500 specimens, including 300 arrow-heads, 100 stone hammers, axes, &c., 20 copper implements, among which latter are some interesting forms."

They are displayed in table and wall-cases.

WISCONSIN HISTORICAL SOCIETY, *Madison, Wis.*

The collection (which is a large and valuable one) was all found within the limits of Wisconsin and mainly in the southern part of the State. It is arranged typically and all specimens are marked with the localities whence obtained. A catalogue exists in manuscript.

In 1876 the number was as follows: *Copper* implements, spears, knives and tomahawks, 109; stone rollers, pestles, scrapers, knives, awls, &c.

600; stone axes (one weighing 8½ lbs.) 365; stone pipes and perforated ornaments, about 250; and over 8000 spear—lance—and arrow-heads.

The collection has been largely increased since 1876. "The especial feature of the collection" (writes Mr. I. S. Bradley, of Madison) "is the great number of large and well made *copper* implements, and some remarkably fine stone axes."

The collection is displayed in horizontal glass cases.

WYOMING HISTORICAL AND GEOLOGICAL SOCIETY, *Wilkes-Barre, Pa.*

"This cabinet originated in the year 1858, the date of the foundation of the Society. The collection is in the main made up of local finds, a few specimens being from other places at a distance; it may, however, be considered as a distinctively local collection. It is classified typically, and consists of specimens as follows:

Pottery: 5 specimens as shown in publication No. 4, also 2 specimens of such size as to show the shape, size and design of vessel, and about one-half a bushel of fragments collected for pupose of studying material used in their manufacture, ornamentation, &c.

Net sinkers, 125; *hoes,* 5; *hand-hammers* or *hammer-stones,* 41; *rubbing-stones,* 5; *discoidal stones,* 10; *ceremonial objects,* perforated, 5 as shown on page 352 of Abbott's "Primitive Industry," 2 such as shown on page 356, and 1 as on page 359, and several fragments of same; *totems, gorgets, &c.,* 25, *and fragments; beads,* 5 strings; *pipes,* 15; *celts, skinners and chisels,* 60; and 15 broken specimens; *tomahawks,* 11; *ground-stone axes,* 22; *ground-stone club heads* or *death mauls,* 17; *mortars, stone,* 8; *lignumvitæ* 1; *shallow mortars or lap-stones,* 5, 2 of them bi-concave; *crushers,* 4; *pestles,* 20 perfect, and 14 broken; *plummets,* 8; *engraved stone,* 1; *plows,* 2 ("I have never seen these implements described, and call them plows at a venture;" writes Mr. Sheldon Reynolds, the Curator of the Society, who has kindly furnished the description of the collection), they are about 18 inches long, 4 inches square at one end, retaining the square throughout nearly half their length, they are then rounded and the balance is in shape of a tapering pestle, weighing about 15 or 20 pounds.

Stone last, 1: (Roughly chipped stone bearing close resemblance to a last, and supposed to have been used for that purpose).

Pitted stones, 2: Supposed to have been used for mixing colors in.

Palæolithic instruments, 4.

1 *large flat stone,* evidently used for smoothing (dressing) skins, found covering Indian grave.

Arrow-points, 2400.

Spear-points, 150.

1 *copper spear-point,* found in mound in neighborhood.

3 *crania;* 3 *bows;* 2 *quivers;* 1 *canoe;* 2 *belts wampum.*

The collection is believed to represent in a fair degree generally the articles of ornament, domestic utensils, and weapons of the chase and warfare of the aborigines.

It is displayed in glass-covered table cases; each object bearing a number and the name of the person who gave it; when practicable the number refers to a manuscript descriptive catalogue.

It is catalogued with the other collections of the Society. A separate catalogue of each department is about to be begun.

The localities are given where each specimen was found.

"The stone last is believed to be unique, and perhaps the plows. The engraved stone is an object of interest as representing growing plants, resembling tobacco and corn; the stone is broken, of irregular shape, and about three inches square. (?) Among the arrow-points are some stained a light purple; the coloring extends one-half the length. No analysis of the coloring matter has been made. These arrows are very diminutive, some not more than three-quarters of an inch over all; others somewhat larger. They were found on the flats opposite the city of Wilkes-Barre. Arrow-points of this size are said to be of rare occurrence east of the Allegheny mountains."

NOTE.—The following list embraces the names of Institutions to which letters of inquiry were sent upon information that they were in the possession of collections of specimens of American archæology, but from which no responses have been received.

Academy of Natural Sciences, Baltimore, Md.
Academy of Natural Sciences, San Francisco, Cal.
American Museum of Natural History, New York, N. Y.
Boston Society of Natural History, Boston, Mass.
Bristol (town of), Bristol, R. I.
Bronson Library, Waterbury, Conn.
Brook's Museum, University of Virginia, Va.
Cincinnati Historical and Philosophical Society, Cincinnati, Ohio.
Firelands Historical Society, Norwalk, Ohio.
Franklin Society, Providence, R. I.
Kentucky State Geological Survey, Frankfort, Ky.
Long Island Historical Society, Brooklyn, N. Y.
Macon Public Library, Macon, Ga.
Madisonville Natural History Society, Madisonville, Ohio.
Maine Historical Society, Portland, Me.
Middlebury Historical Society, Middlebury, Conn.
New Hampshire Antiquarian Society, Contoocook, N. H.
Newport Historical Society, Newport, R. I.
New York Historical Society, New York, N. Y.
Toledo Historical and Geographical Society, Toledo, Ohio.
University of California, San Francisco.
Vineland Historical and Antiquarian Society, Vineland, N. J.
Western Reserve Historical Society, Cleveland, Ohio.
Yale College, New Haven, Conn.
Young Men's Library, Atlanta, Ga.

Photodynamic Notes, VIII. *By Pliny Earle Chase, LL.D.*

(Read before the American Philosophical Society, May 18, 1883.)

376. *Virials.*

The theory of the virial, or mean *vis viva* during stationary motion, enables us to coördinate all forms of cyclical motion : rotary, orbital and oscillatory. The grandest manifestations of the virial, which are given in cosmical motion, must be governed by the same laws as govern molecular movements. The complete development of the theory should, therefore, remove all the obscurity which still clings to the doctrine of radiodynamic unity. The science of comparative kinetics is greatly indebted to Clausius, for his presentation of the theory, for the consequent simplicity which it introduces into the solution of problems which would otherwise be exceedingly complicated and for the facility of explanation, which it gives for methods which are substantially the same, but which, on account of their novelty, have been often misunderstood.

377. *Virial Postulates.*

My photodynamic and other physical researches have been rewarded by a great number of cosmical illustrations of virial efficiency, which are based upon the following postulates :

1. That cosmical masses represent internal energies, such as would be found if they were condensed from some primitive tenuous, elastic form of matter.

2. That all chemical elements may have been condensed, in like manner, from a single primitive element or æther.

3. That the velocity which enters into the primitive radial virial of the oscillating æthereal particles is the velocity of light (v_{λ}).

4. That the stationary motions of central inert masses, which represent the equal actions and reactions of primitive and derived virials should continue until the velocity of the primitive virial has been alternately acquired and lost.

5. That all stationary motions which represent equal actions and reactions should be harmonic.

378. *Stellar Virials.*

Solar or Stellar centres of planetary systems are central inert masses (Post. 4), which are endowed with velocities of stationary motion, tending to give velocities of stationary revolution, sending forth æthereal oscillations with the velocity of light (Post. 3) and representing internal energies like those which would spring from nebular condensation (Post. 1). Their central stationary motions should, therefore, be cyclically determined by the alternate acquisition and exhaustion of the radial velocity of light (Post. 4). Herschel (*Outlines of Astronomy*, Sect. 399) discoursed elo-

quently on the Sun's rays as "the ultimate source of almost every motion which takes place on the surface of the earth." We may, therefore, reasonably look to them for evidences of virial efficiency, in various forms, which will furnish satisfactory proof of radiodynamic unity.

379. *Equal Virial Action and Reaction.*

Circular orbital velocity which is due to solar action may be represented by the equation

$$v_n = \sqrt{g_n r_n} \qquad 1.$$

The limiting value of v_n, which it cannot exceed, is found at Sun's surface (r_0), where g_0 is a maximum. It may be represented by

$$[v_0] = \sqrt{g_0 r_0} \qquad 2.$$

The third and fourth postulates lead to the equation

$$v_\lambda = g_0 t_0 \qquad 3.$$

This equation should hold good for all values of r in an expanding or contracting nucleus, inasmuch as g varies inversely as r^2 and the principle of conservation of areas requires that the time of rotation should vary directly as r^2. The product of the two factors should, therefore, be constant.

380. *Numerical Verification.*

Taking Sun's semi-diameter (r_0) as the unit of length, and the British Nautical Almanac estimate of Sun's apparent semi-diameter (961.″83) as the parallactic unit, we find, for Earth's semi-axis major

$$\rho_3 = 214.45 r_0 \qquad 4.$$

Earth's mean orbital velocity (1) may be found by dividing $2\,\pi\rho_3$ by the number of seconds in a year (31558149). This gives

$$v_3 = .0000001990099 \rho_3 \qquad 5.$$

This value varies slightly with varying orbital eccentricity. The greatest secular range of variation, however, is less than $\frac{1}{8}$ of one per cent.

Circular orbital velocity varying inversely as the square root of the radius-vector, we find (2), (4), (5)

$$[v_0] = .00000291562 \rho_3 = .000625255 r_0 \qquad 6.$$

$$g_0 = .0000003909445 r_0 \qquad 7.$$

Struve's constant of aberration gives, by (3) and (7)

$$v_\lambda = g_0 t_0 = 214.45 r_0 \div 497.827 = .430772 r_0 \qquad 8.$$

$$t_0 = 1101876 \text{ sec.} = 12.753 \text{ days} \qquad 9.$$

This gives for a double oscillation, or complete rotation of Sun, 25.506 days. Laplace's estimate was 25.5 days. The motion of sun-spots near the equator is accelerated by centrifugal force, tendencies to orbital velocity, "repulsion," or some other unknown influence. Spörer's formula gives 24.62 days for the period at the equator, where no spots have ever been observed. His third estimate, for 1866, was 25.234 days.

381. *Virials of Rotation.*

The rotating æthereal tendency of stationary motion, which is limited

by equations (2) and (3), gives the following value for the limiting radius (ρ_λ) of orbital and æthereal tendencies :

$$\rho_\lambda = \frac{v_\lambda}{[r_0]} r_0 = v_\lambda \sqrt{\frac{r_0}{g_0}} \qquad 10.$$

Laplace's limit (l) of equal rotary and orbital velocity is given by the equation

$$l = \left(\frac{\rho_\lambda}{\pi r_0}\right)^{\frac{3}{2}} r_0 = \left(\frac{\rho_\lambda}{\pi}\right)^{\frac{3}{2}} r_0^{-\frac{1}{2}} \qquad 11.$$

The limit at which the equatorial velocity of stationary motion would give v_0 is

$$\left(\frac{l}{r_0}\right)^{\frac{2}{3}} r_0 = l^{\frac{2}{3}} \div r_0^{\frac{1}{3}} = \rho_\lambda \div \pi \qquad 12.$$

The limit at which the equatorial velocity of stationary motion would give v_λ, as deduced from (10) and (12), is

$$[l] = \rho_\lambda^2 \div \pi r_0 \qquad 13.$$

The limit of a homogeneous, elastic, æthereal atmosphere which would propagate undulations with the velocity of light, is

$$M = \pi [l] = \rho_\lambda^2 \div r_0 \qquad 14.$$

382. *Virial Centres of Oscillation.*

The virials of rotating tendency must influence grosser inert particles or masses, as well as the æthereal atmosphere. Loci of important oscillatory influence may be found at radii of mean æthereal momentum (ρ_a), of linear oscillation (ρ_β), of reciprocal linear oscillation (ρ_γ), of spherical oscillation (ρ_δ), and of reciprocal spherical oscillation (ρ_ϵ). Taking ρ_λ as the common virial locus of these several oscillating tendencies, we have

$$\rho_a = 2\rho_\lambda \qquad 15.$$

$$\rho_\beta = 1.5\rho_\lambda \qquad 16.$$

$$\rho_\gamma = 3\rho_\lambda \qquad 17.$$

$$\rho_\delta = 2.5\rho_\lambda \qquad 18.$$

$$\rho_\varepsilon = \tfrac{5}{3}\rho_\lambda \qquad 19.$$

All of these forms of action and reaction must be called into play by solar and stellar radiation, and they should all be studied in investigating the maintenance of cosmical energy.

383. *Maintained Vibrations.*

Lord Rayleigh (*Phil Mag.*, April, 1883) discusses a vibrating system which is subject to dissipative forces, and the necessity, when the vibrations are maintained, that the vibrating body should be in connection with a source of energy. In the usual equation

$$\frac{d^2\theta}{dt^2} + \frac{d\theta}{dt} + n^2\theta = 0 \qquad 20.$$

two principal classes of maintained vibrations may be distinguished; the more extensive class being that in which the magnitude and phase of the sustaining force depend in an approximately constant manner, upon the amplitude and phase of the vibration itself. The only case in which, according to (20), a steady vibration is possible, is when the complete value of κ is zero. If any portion of the energy of cosmical masses is dissipated, æthereal energy must be proportionately increased. The æther accordingly becomes a "source of energy," and although we are not yet able to see fully how the connection of this source with solar radiations is kept up, the equivalence of v_λ to v_γ (Note 321) shows that it is kept up, through cyclical actions which cover a period of about 12¾ days.

384. *Virials of Wave Propagation.*

It has often been tacitly assumed that there is no actual radial oscillation in luminous radiation, like that of the atmospheric particles in the propagation of sound-waves. In 1872 (*Proc. Amer. Phil. Soc.*, xii, 394) I showed that the secondary centre of oscillation, on returning from the centre of linear oscillation towards the linear centre, is at $\frac{5}{9}$ of the extreme excursion. Hence the tangential virial of an oscillating æthereal particle (μ_a), is $\frac{9}{5}$ of the radial virial of the same particle (μ_β). More than five years afterwards (*Phil. Mag.* [5], iii, 453; iv, 209), Maxwell stated that the ratio of the virial velocity is $\sqrt{\frac{9}{5}}$, but he gave no reason for his inference and none has yet been found among his unpublished papers. His statement and mine are substantially identical, the only difference being that he looked to the relative mean momentum of the oscillating particles, while I looked to their relative virials.

$$\mu_a = 1.8\ \mu_\beta \qquad 21.$$

385. *Time-Relations of Inertia.*

The question of instantaneous action is still, and probably will long continue to be, a mooted one. The most impressive form in which it has ever been presented, is Laplace's statement that gravitating action requires a velocity which is more than 100,000,000 times as great as the velocity of light, and that it may be assumed to be absolutely instantaneous at all distances. It is sometimes said that inertia is instantaneously overcome. This may, perhaps, be true in some sense, but we cannot know that it is so, until we know more than we have yet learned about the way in which velocity is transferred from one body to another. In general physical investigations the element of time, usually in the form of time-integrals, requires consideration whenever there is any change of motion.

386. *Correlation of Virials.*

Questions of kinetic unity and correlation are greatly complicated by differences of inertia and by the lack of generally recognized standards of comparison. If all forms of force are transmitted through æthereal intervention, all virials should be capable of representation in terms of æthereal mass and velocity. The velocity of luminous undulation then becomes a

natural standard of velocity. Whenever velocity is imparted or destroyed by gradual accelerations or retardations (f), a time can always be found which will give the equation

$$ft = v_\lambda \qquad 22.$$

By cöordinating the times which are required by this equation in different forms of energy, the evidences of primitive kinetic unity may be multiplied indefinitely.

387. *A Natural Unit of Time.*

Errors of measurement which are of any specific magnitude, increase in relative importance inversely as the magnitude which is measured. An error of .0001 inch in any of the dimensions of a microscopic object would be very serious, but in an object which is a foot or more in length it would be insignificant. It is desirable, therefore, in studying kinetic unity, to begin with phenomena which involve kinetic maxima. The most far-reaching acceleration of which we can make measurements, is that of gravitation, and the greatest gravitating acceleration of which we have any direct knowledge (g_0) is found at Sun's surface. Substituting in (22) we have

$$ft = g_0 t_0 = v_\lambda \qquad 23.$$

Therefore, Laplace's principle of periodicity (Note 333), the collateral hypotheses of various investigators (Note 278), the fourth virial postulate (Note 377), the considerations which make v_λ a natural unit of velocity (Note 386), as well as many other correlations of photodynamic and general cyclical energy, point to the time of solar rotary oscillation as a natural unit of time.

388. *Virial Transfers.*

An energy which is wholly transferred from one æthereal mass to another equivalent æthereal mass, must be accompanied by a like transfer of velocity, whether the transfer is in the form of potential (v_α), work (v_β), gravitation (v_γ), torsion (v_δ), electricity (v_ϵ), rotation (v_ζ), revolution (v_η), heat (v_θ), chemical affinity (v_κ), or luminous undulation (v_λ). We have, therefore, for limiting velocities when all the units are homologous,

$$v_\alpha = v_\beta = v_\gamma = v_\delta = v_\epsilon = v_\zeta = v_\eta = v_\theta = v_\kappa = v_\lambda \qquad 24.$$

In cyclical movements which are due to virial tranfers, these several equivalents may be indicated by equations which are based on the third and fourth postulates (Note 377) and which are analogous to (3).

389. *Cardinal Limits.*

In seeking further numerical verifications of the foregoing virial equations, we find the photodynamic limiting radius of orbital and æthereal tendencies (10) by substituting (6) and (8).

$$\rho_\lambda = 688.954\, r_0 = 3.212654 \rho_3 \qquad 25.$$

Substituting (25) in (11), we get for Laplace's limit

$$l = 36.366 r_0 \qquad 26.$$

The substitution of (25) in (12) gives

$\rho_\lambda + \pi = 219.301 r_\circ = 1.0226 \rho_3$ 27.

Hence by (13), we find for the locus of v_λ in solar rotation,

$[l] = 151088.1 r_\circ = 704.538 \rho_3$ 28.

And the solar modulus of light (14) is

$M = 474657.3\, r_\circ = 2213.37\, \rho_3$ 29.

390. *Influence of Synchronous Radial and Tangential Virials.*

The theoretical variation of æthereal density within the limits of our planetary system (Note 240) is so slight that the several vector radii may be considered as indicative of virial projection against a resistance which is nearly uniform. The radial and tangential virials (Note 384) being synchronous, we may with reason look for cosmical evidences of the synchronism. Accordingly we find, from (21) and (25), the following regular series of approximations to planetary loci. The subscripts, 1, 2, 3, denote, respectively, secular perihelion, mean, secular aphelion.

$1{\cdot}8^{-4}\,\rho_\lambda$	=	$\cdot3060\rho_3$	Mercury$_1$	=	$\cdot2974\rho_3$	30.
$1{\cdot}8^{-3}\,\rho_\lambda$	=	$\cdot5509\rho_3$	Venus$_1$	=	$\cdot6722\rho_3$	31.
$1{\cdot}8^{-2}\,\rho_\lambda$	=	$\cdot9916\rho_3$	Earth$_2$	=	$1{\cdot}0000\rho_3$	32.
$1{\cdot}8^{-1}\,\rho_\lambda$	=	$1{\cdot}7848\rho_3$	Mars$_2$	=	$1{\cdot}7365\rho_3$	33.
$1{\cdot}8^{0}\,\rho_\lambda$	=	$3{\cdot}2127\rho_3$	Asteroid 108	=	$3{\cdot}2120\rho_3$	34.
$1{\cdot}8^{1}\,\rho_\lambda$	=	$5{\cdot}7828\rho_3$	Jupiter$_2$	=	$5{\cdot}5193\rho_3$	35.
$1{\cdot}8^{2}\,\rho_\lambda$	=	$10{\cdot}4090\rho_3$	Saturn$_2$	=	$10{\cdot}3433\rho_3$	36.
$1{\cdot}8^{3}\,\rho_\lambda$	=	$18{\cdot}7362\rho_3$	Uranus$_2$	=	$19{\cdot}1836\rho_3$	37.
$1{\cdot}8^{4}\,\rho_\lambda$	=	$33{\cdot}7252\rho_3$	Neptune$_2$	=	$30{\cdot}4696\rho_3$	38.
Geom'l Mean	=	$3{\cdot}2127\rho_3$	Geom'l Mean	=	$3{\cdot}2200\rho_3$	39.

All of these approximations represent loci of belt-condensation, for the respective planets, which are in accordance with the nebular hypothesis. The geometrical means differ by less than $\frac{1}{4}$ of one per cent. The photodynamic mean represents the semi-axis major of Asteroid 108; the planetary mean, the semi-axis major of Asteroid 122. The second photodynamic locus ($\cdot5509\rho_3$) is, within less than one per cent., the arithmetical mean between the semi-axes major of Mercury and Venus ($\cdot5552$).

391. *Photodynamic Centre of Various Oscillations.*

The common virial locus (Note 332) of mean momentum, linear oscillation, spherical oscillation, and reciprocal oscillations, gives the following planetary approximations by (15), (16), (17), (18), (19) and (25):

ρ_α	=	$6{\cdot}4253\rho_3$	Cardinal centre	=	$6.4451\rho_3$	40.
ρ_β	=	$4{\cdot}8190\rho_3$	Jupiter$_1$	=	$4{\cdot}8863\rho_3$	41.
ρ_γ	=	$9{\cdot}6380\rho_3$	Saturn$_2$	=	$9{\cdot}5389\rho_3$	42.
ρ_δ	=	$8{\cdot}0318\rho_3$	.4 Uranus$_3$	=	$8{\cdot}2717\rho_3$	43.
ρ_ε	=	$5{\cdot}3545\rho_3$	Jupiter$_2$	=	$5{\cdot}2028\rho_3$	44.
Ar. Mean	=	$6{\cdot}8537\rho_3$	Ar. Mean	=	$6{\cdot}8690\rho_3$	45.
Ge. Mean	=	$6{\cdot}6325\rho_3$	Ge. Mean	=	$6{\cdot}6421\rho_3$	46.

It will be seen from (43) that the second locus of spherical rotary projection from ρ_λ, ($2\cdot5 \times 2\cdot5\rho_\lambda = 20\cdot0795\rho_3$), is within the secular orbital range of Uranus. The cardinal centre (40) is the centre of gravity, at conjunction, of Saturn$_2$ and Jupiter$_3$. It represents, therefore, the locus of mean rotary momentum for their combined masses, at the time of Jupiter's incipient rupturing subsidence, according to Herschel's modification of the nebular hypothesis.

392. *Further Relations of the Cardinal Centre.*

The cardinal centre, which introduces the series in the foregoing note, also represents important relations to the following additional virial loci:

$\rho_\zeta =$	$\sqrt{\Sigma m\rho^2 \div \Sigma m}$	$= 9.2443\rho_3$	47.
$\rho_\eta =$	$\Sigma m\rho \div \Sigma m$	$= 7\cdot5228\rho_3$	48.
$\rho_\theta =$	$\frac{1}{2}$ (Saturn$_2$ + Jupiter$_3$)	$= 7\cdot5291\rho_3$	49.
$\rho_\iota =$	$\frac{1}{2}$ ($6\cdot4451 + 8\cdot2717$)	$= 7\cdot3584\rho_3$	50.
$\rho_\kappa =$	$\frac{1}{4}$ Neptune$_2$	$= 7\cdot5084\rho_3$	51.

The locus of mean planetary nebular inertia (47) is in Saturn's orbit, where the rings, the satellite system and the specific gravity bear witness to the results of nebular condensation. The locus of mean planetary nebular momentum (48) approximates closely to the arithmetical mean between Saturn$_2$ and Jupiter$_3$ (49), to the arithmetical mean between the cardinal centre and the incipient virial locus of spherical rotation for Uranus (50), and to the virial locus for the mean linear momentum of Neptune's semi-axis major (51).

393. *Primitive Virial Influence on Mass.*

The virial radius of mean momentum not only determines the centre of gravity of the two chief planetary masses (15), (40), but it also determines the relative masses of Sun (m_0) and Jupiter (m_5) at initial nebular rupture (secular perihelion). We find, accordingly,

$$m_0 r_0 = m_5 \rho_{5,1} \qquad 52.$$

Stockwell's estimate of Jupiter's secular eccentricity is $\cdot0608274$. This gives $\rho_{5,1} = \cdot9391726 \times 5\cdot202798 \times 214\cdot45 = 1047\cdot872 r_0$. Therefore (52):

$$m_0 = 1047.872\ m_5 \qquad 53.$$

Bessel's estimate is $1047\cdot879$. This harmony is the more significant because Jupiter's nebular locus of incipient rupture ($4\cdot8863$) is central between the loci of incipient subsidence of Uranus ($20\cdot6792$) and Neptune ($30\cdot4696$) at opposition.

$$\rho_{5,1} = \tfrac{1}{2}\,(\rho_{7,3} - \rho_{6,3}) \qquad 54.$$

394. *Successive Orders of Photodynamic Influence.*

While Jupiter traverses the primitive nebular centre, Earth traverses the centre of the belt of greatest condensation.

$$\tfrac{1}{2}\,(\rho_{1,1} + \rho_{4,2}) = \rho_3 \qquad 55.$$

Stockwell's estimates for the secular limits of the dense belt (Mercury, and $Mars_3$) are, $\rho_{1,1} = \cdot 2974$; $\rho_{4,3} = 1\cdot 7365$. This gives for (55) $1\cdot 0169\, \rho_3$, which is nearly $\frac{1}{\pi}$ of the mean proportional (27) between Sun's radius (r_0) and the solar modulus of light (29). These successive indications of virial influence upon Saturn and Jupiter (40), Sun and Jupiter (53), Uranus and Neptune (54), and the relative positions of the dense planets, are full of suggestive interest.

395. *Virials of Secondary Rotations.*

While the rotation of the chief nucleal centre (Sun) is determined by the velocity of light (3), the rotations of the secondary centres of nebulosity (Jupiter) and condensation (Earth) are determined, respectively, by circular orbital velocities at Sun's surface $[v_0]$ and at the mean centre of gravity of Sun and Jupiter $[v_a]$.

$$g_5 t_5 = [v_0] = \sqrt{g_0 r_0} \qquad 56.$$

$$g_3 t_3 = [v_a] = \sqrt{g_a r_a} \qquad 57.$$

The data for the solution of (57) have been more accurately and satisfactorily determined than for (56).

$$g_3 t_3 = \frac{32\cdot 088}{5280} \times \frac{86164\cdot 08}{2} = 261\cdot 821 \text{ miles} \qquad 58.$$

396. *Jupiter's Diameter and Density.*

Circular orbital velocity varying inversely as $\sqrt{r}$, we find (52), (53), (57), (58)

$$g_5 t_5 = [v_0] = g_3 t_3 \div \sqrt{.9391726} = 270\cdot 167 \text{ miles} \qquad 59.$$

$$[v_3] = [v_0] \div \sqrt{214\cdot 45} = 18\cdot 449 \text{ miles} \qquad 60.$$

Hall's estimate of the period of Jupiter's rotation ($9^h\ 55^m\ 26^s.5$) gives

$$t_5 = 4^h\ 57^m\ 43.25 = 17863.25 \text{ seconds} \qquad 61.$$

Substituting this value in (59) we find

$$g_5 = 79\cdot 856 \text{ ft.} = 2\cdot 4887\, g_3 \qquad 62.$$

Hence, by (53) and (69)

$$m_5 = 315\cdot 38\, m_3 \qquad 63.$$

$$r_5 = 11\cdot 257 r_3 \qquad 64.$$

$$\delta_5 = \cdot 2211 \delta_3 \qquad 65.$$

Different estimates of Jupiter's mean apparent semi-diameter give values for r_5 ranging between $10\cdot 8 r_3$ and $11\cdot 5 r_3$

397. *Sun's Mass and Distance.*

Earth's gravitating acceleration and its orbital velocity (60) being known, we have all the data which are needed for estimating Sun's relative mass and mean distance.

$$\rho_3 = 31{,}558{,}149\ [v_3] \div 2\pi = 92{,}662{,}000 \text{ miles} \qquad 66.$$

$$r_0 = \rho_3 \div 214\cdot 45 = 432{,}090 \text{ miles} \qquad 67.$$

At Earth's surface, $\sqrt{gr} = 4{\cdot}9073$. It varies as $\sqrt{\frac{m}{r}}$. Therefore (60)

$$\frac{m_\alpha}{\rho_3} \cdot \frac{m_\lambda}{r_2} : : 18{\cdot}449^2 : 4{\cdot}9073^2 \qquad 68.$$

$$m_\alpha : m_2 \;.\; : 330482 : 1 \qquad 69.$$

All of the results which have been drawn from (3), (56), and (57) involve the principle of persistency of vibrations, by which waves tend to propagate themselves indefinitely, with the velocity which is due to their locus of origination.

398. *Masses of Earth and Venus.*

The influence of Jupiter's locus of incipient subsidence on the comparative masses of Jupiter and Saturn, finds some analogy in the two chief planets of the dense belt, Earth and Venus.

$$m_2\rho_{2\cdot3} = m_3\rho_5 \qquad 70.$$

Substituting Stockwell's estimate of the secular aphelion of Venus ($\rho_{2\cdot3} = {\cdot}7744234\rho_3$) in (60), (70).

$$m_\alpha = 426750m_2 \qquad 71.$$

Hill's estimate is 427240, which differs from (71) by less than $\frac{1}{8}$ of one per cent. The combined virial estimate of Earth's relative mass (69) differs from the purely oscillatory estimate (Note 23) by less than $\frac{1}{5}$ of one per cent.

399. *Comparisons of Potential.*

In order to test the numerical accuracy of the general equation of kinetic velocities (24) we may begin with the consideration of potential energy, which has been largely treated in thermodynamics. Gravitating potential is usually measured by the height of possible fall, or of *virtual* fall, since the heights which are considered are commonly so small that the variation of g is insignificant. The time of fall (t_α), or the velocity which would be communicated by the fall (v_α), might be taken with equal propriety as the basis of measurement and comparison. The cosmical determination of Joule's equivalent (*Proc. Am. Phil. Soc.*, XIX, 20), shows the importance and advantage of adopting fundamental units which can be readily employed in the greatest possible variety of directions.

The general equation of fundamental velocity (24) rests on Laplace's principle of periodicity, "that the state of a system of bodies becomes periodic when the effort of primitive conditions of movement has disappeared by the action of resistances." Hence (3), (8).

$$v_\lambda = v_\gamma \qquad 72.$$

Moreover, the natural standards of time, gravitating acceleration, distance, oscillation and undulatory velocity which are indicated by the solar periodicity of synchronous rotation and evolution at Laplace's limit, solar superficial attraction Sun's semi-diameter, and luminous radiation, obviously give the following further equality.

$$v_\alpha = v_\beta = v_\zeta = v_\eta = v_\theta = v_\lambda \qquad 73.$$

400. *Completion of Correlation.*

In Coulomb's formula of torsional elasticity (Note 162), if we substitute $\frac{m}{2}$ for f, $gt^2 = M$ (29) and

$$gt = v_\lambda = v_\delta \qquad 74.$$

The investigations of Weber, Kohlrausch, Thomson, Maxwell, Ayrton, and Perry have shown that

$$v_\lambda = v_\varepsilon \qquad 75.$$

Notes 16, 90–3, 97 give various ways of coördinating chemical and cosmical actions with luminous undulation, so as to get the equation

$$v_\kappa = v_\lambda \qquad 76.$$

In throwing a ball into the air, the thermal equivalent of projectile force is equivalent to the product of the mass by the sum of the retarding resistances. In solar superficial radiation, the gravitating reaction is exhausted in a half rotation. By a simple extension of these principles we have deduced equations 73–6, which, when combined, give a complete practical verification of the general kinetic correlation (24).

401. *Phyllotaxy and Harmony of Absorption Bands.*

Langley's observations with the spectro-bolometer, at Allegheny Observatory and on the summit of Mt. Whitney, show four remarkable absorption bands in the infra-red portion of the solar spectrum, at 0.μ94, 1.μ14, 1.μ37 and 1.μ83. These wave-lengths are very nearly proportional to the numbers 4, 5, 6, 8, as is shown by the following table:

	Harmonic.	Observed.
α	·92	·94
β	1·15	1·14
γ	1·38	1·37
δ	1·84	1·83

They give, therefore, the following phyllotactic approximations: $\alpha \div \beta = 2 \times \frac{2}{5}$; $\alpha \div \gamma = \frac{2}{3}$; $\alpha \div \delta = \frac{1}{2}$; $\beta \div \delta = \frac{5}{8}$. The phyllotactic harmony is modified by an approximate repetition of the harmonic ratio $\frac{5}{6}$.

	Harmonic.	Observed.
α_0	95	.94
β_0	114	1.14
γ_0	136.8	1.37

We thus find, wherever we look, abundant evidence, not only of primary harmonic influence, but also of secondary and subordinate modifications which need to be carefully studied in connection with virial researches.

402. *Consequences of Ferrel's Law.*

The science of Meteorology may, for many good reasons, be regarded as a peculiarly American science. William Ferrel's discussion of the motion of fluids and solids relative to the Earth's surface, which was first published in the summer of 1856, placed the laws of cyclonism and anticylonism on

a solid mathematical basis. He showed that, in the northern hemisphere, all moving bodies are constantly subjected, in consequence of the Earth's rotation, to a deflection towards the right hand. Hence all atmospheric surface currents which are mainly governed by a downward pressure, tend to curve in the direction of the hands of a watch, or successively through north, east, south, west. All surface currents which are mainly governed by an upward pressure, tend to flow in an opposite direction, or through north, west, south, east.* The heavy winds are called anticyclonic; the light winds, cyclonic.

There can be no descending currents in one place without ascending currents in another; therefore, in every atmospheric disturbance, there must be simultaneous cyclonic and anticyclonic winds. Such disturbances originate either in an unusual cooling and condensation, or in an unusual heating and expansion of air. In the former case the inflow, in the upper regions of the atmosphere, will produce an increased pressure. In the latter, the outflow will produce a diminution of pressure. In the restoration of equilibrium, currents of warm air are often brought into contact with colder currents. If the currents are both saturated with moisture, or if they contain more vapor than can be retained under the temperature of the mixed currents, precipitation takes place, in the form of rain, hail, or snow. This precipitation reduces the weight of the atmospheric column and the barometer falls. Accordingly, there is a constantly increasing tendency to cyclonism about storm centres, and there has been a very prevalent disposition to look upon all storms as of cyclonic origin.

A little reflection, however, will show that the initial mixture of currents may be due to either of the causes above mentioned; either to the flow of warmer air into a cold depression at the top of the atmosphere, or to a flow of cold air, at the earth's surface, towards a region of low barometric pressure. In the former case, the initial superficial currents are determined by a downward pressure, and they are, therefore, anticyclonic; in the latter they are determined by an upward pressure and are cyclonic.

A careful study of the weather maps shows that the heaviest rains and snows occur in advance of the centres of low barometric pressure, or in the rear of the centres of high barometric pressure. If storms began in the cyclonic currents, the reverse should be true; the greatest effect following the low centre and preceding the high centre.

The frequent failures of forecasts, during the past winter, seem to have been mainly due to a misinterpretation or a misconception of these facts, to which the writer first called attention in 1871.

403. *Study of Stormy Anticyclonism.*

Loomis's discussions (Note 367) show the need of watching the development of storms at all stages, from the first indications of atmospheric

*This will be evident, if we imagine ourselves to be lying in the current and facing the direction towards which the pressure tends.

disturbance, until the restoration of fair weather. The limit between anticyclonic and cyclonic tendencies, may be approximately assumed to be midway between the centres of high and low barometric pressure. All cloudiness or precipitation between the limit and the high centre, represents anticyclonic influence; all between the limit and the low centre represents cyclonic influence. Local cyclonism sets in soon after precipitation begins, and the anticyclonic influence is thus partially hidden; but a critical examination of the weather maps will show that the prevailing currents of the region often continue to be anticyclonic until the rain or snow is nearly, or quite over. The evidences of storm breeding and stormy anticyclonism will be still more striking, if the changes of barometric pressure are studied in connection with the beginnings and subsequent growth of cirrus, cumulus, and nimbus clouds, as well as with the rainfall and the final breaking up of cloudiness. There are good reasons for believing that such study, systematically and thoroughly continued under the direction and with the facilities of the Signal Service Bureau, would raise the successful verifications of the Washington forecasts to an average of at least ninety-five per cent.

404. *Pressure of Warm Air.*

Dr. Köppen, in discussing Ley's work on the winds prevailing in Western Europe, announces four new theorems (*Ann. hydr. und magnet. marit. meteor.*, 1882; cited by *Science*, **499**). 1. The air-currents deviate from the isobars towards the side of the lower pressure in the lower atmosphere, and of the higher pressure in the upper atmosphere. 2. An excess of pressure exists upon the side of the warmer air-columns. 3. The depressions advance approximately in the direction of the air-current which has a preponderance of accumulated energy. 4. The state of motion of a certain mean layer, of which the height is still to be determined, can in general be substituted for the onward movement of the vortex. A systematic comparison of these propositions with observations and with Blasius's discussion of äerial currents (*Storms*, chapter iii), may contribute towards a fuller knowledge of stormy anticyclonism. It will also be interesting and instructive to see how readily Köppen's theorems can be deduced from Ferrel's laws.

405. *Solar-Barometric Virials.*

The first physical paper which I communicated to the American Philosophical Society (*Proc. A. P. S.*, ix., 283-8) was based on virial considerations, but the discussions of Clausius had not prepared the way for their general acceptance. Accordingly, the method of treatment was so new, that many persons looked upon the results merely as curious and, perhaps, accidental coincidences. The foregoing relations of virial influence to time of rotary oscillation enable us to reach the same results in a more simple way.

The mean barometric fluctuations, both daily and annual, may be re-

garded as functions of time, mass and distance. The mean daily disturbances take place at $r_1 = 3962.8$ miles from the virial centre; the mean annual disturbances at ρ_1 = Earth's semi-axis major from their virial centre. The disturbed atmospheric mass and the equilibrating value of g are the same in both cases. The virtual potential of daily rotation is $\frac{g}{2} \times 86164.09^2 =$ 22,559,593.75 miles. Gen. Sabine's means of five years' observations at St. Helena, show a daily barometric range of .067 in., and an annual range of .135 in. (see *Proc. Am. Phil. Soc.*, x, 375, foot-note). The geographical, magnetic and climatic situation of St. Helena is such as to give the following simple harmonic approximation for ρ_1 (Note 377; 5).

$$.067^2 : 135^2 : : 22,559,593.75 : 91,590,200 \text{ miles.}$$

406. *Encke's Comet.*

Dr. O. Backlund (*Copernicus*, Feb. 1883; cited in *Science*, **531**), says that "the investigations hitherto made of the theory of Encke's comet really prove nothing as to the existence of a resisting medium in space. Even if we should succeed by such an hypothesis to explain sufficiently the increase of the mean motion and the decrease of the eccentricity during the period 1819–48, a simple hypothesis like this will not at the same time suffice for the motion of the comet after 1865, as the variation of the mean movement after that time has most probably become different. Not until the period 1865–81, and its connection with the earlier one have been fully discussed, will it perhaps become possible to find indications of the nature of the unknown forces which act on the comet." If an æthereal medium is set in vibration by the passage of comets or other cosmical bodies, there will be, as in the case of tidal disturbances, both accelerating and retarding influences. We must know more than we now do, of the nature of the medium as well as of the laws of elasticity, before it will be safe to dogmatize about a resisting medium or about the second law of thermodynamics. The equality of action and reaction may, perhaps, set limits both to nucleal condensation and to æthereal expansion, the two limits being opposite phases of cyclical changes which all matter is always undergoing. The unity of energy which is indicated by æthereal relations of mass and velocity (Notes 388, 400), gives great likelihood to this hypothesis.

407. *Sound-Spectra.*

Frazer's "Examination of the phonograph record under the microscope" (*Jour. of the Franklin Inst.*, lxxv, 348; *Proc. Am. Phil. Soc.*, xiii, 531), showed that each of the alphabetic sounds has a special combination of vibrations, which may be visibly impressed upon a metallic sheet. The harmonic correspondence between the wave-lengths of musical notes and those of the principal lines in the visible spectrum (*Proc. Am. Phil. Soc.*, xiii, 149), increases the probability that there may be an unbroken series of waves, from the lowest audible sound to the highest actinic impulse. Mayer's experiments with the antennæ of mosquitos and Langley's ob-

servations of absorption bands (Note 401), approximate the gamuts of light and sound and suggest the desirableness of some more sensitive method for recording audible waves and interferences than is furnished by the phonograph. The radial virials of light and the tangential virials of sound (Note 390) furnish a field for research which is almost wholly unexplored. In view of the wonderful advance of spectral photography during the last decade, we may venture to hope that the record may sometime be extended so as to include the interferences of sound-waves.

408. *Investigators of Spectral Harmony.*

The earliest indications of harmony in spectral lines of which I have found any record, were given by Prof. Gustavus Hinrichs, in the American Journal of Science for 1864 (vol. xxxviii, p. 31, seq). In the Comptes Rendus of the French Academy, for 1869 and 1870, Lecoq de Boisbaudran published several harmonies of a character analogous to those of Hinrichs, his first paper being deemed of so much importance that the Academy allowed its insertion without abridgment, although it exceeded the statutory length. He referred to a communication of Mascart, on the same subject, in August, 1868, and also to a *pli cacheté* of his own which was deposited in the archives of the Academy in 1865. G. Johnstone Stoney (*Rept. Brit. Assoc.*, 1870; *Proc. Roy. Irish Acad.*, 1871; *P. Mag.*, 1871) and J. L. Soret (*Bib. Universelle*, Sept. 15, 1871, cited in *P. Mag.*, 1871, xlii, 464) seem to have been next on the list. My own investigations began in 1864, with the study of "oscillations moving with the velocity of light" (*Proc. Am Phil. Soc.*, ix., 408), but my first indications of harmonic wave-lengths were not published until 1873 (*Ib.*, xiii, 150). Guided by a conviction of the physical necessity that all æthereal undulations must be harmonic, I have been led into the discovery of a great variety of spectral and other coördinated harmonies.

409. *Velocity of Wave Propagation.*

As there has been some misapprehension with regard to my deduction of the relation between the mean velocity of oscillating æthereal particles and the velocity of wave propagation (Note 384), it may be well to explain the ground on which it rests. In considering the "uniform wave of oscillation," in a star which is rotating under the condition that $g_0 t_0 = v_\lambda$ (Note 379), the *vis viva* of a revolving particle at l (Note 381), is $\frac{1}{2}$ as great as the *vis viva* of the same particle from the indefinite fall* which has produced central condensation. *Vis viva* varies as distance of possible projection against uniform resistance; therefore l and $\frac{1}{2} l$ may be taken, respectively, as the measures of the virials of indefinite and of virtual fall. Hence arises a tendency to the formation of an oscillatory node at $\frac{1}{2} l$, together with a tendency to the radial projection of the node, in the equatorial plane, by

* This is rigidly true only when the fall is infinite, but in falling from Neptune to Sun the deviation from exactness would be less than $\frac{1}{15}$ of one per cent.

the centrifugal force of rotation. The direct and reciprocal centres of linear oscillation, at $\frac{2}{3}\,l$ and $\frac{1}{3}\,l$, tend to throw the node at $\frac{1}{2}\,l$ from or toward the centre. The reciprocal centre, $\frac{1}{3}\,l$, is pivotal in respect to the direct centre, $\frac{2}{3}\,l$, thus producing a secondary centre of linear oscillation at $\frac{5}{9}\,l$. This indicates the relative *vis viva* of radial projection which corresponds to an oscillatory tangential *vis viva* of l. The corresponding relative velocity is $\sqrt{\frac{5}{9}}$.

410. *Propagation of Explosive Waves.*

Berthelot and Vieille (*Ann. de Chim. et de Phys.*, xxviii, 293) give the equation $\theta_1 = \theta_0 \sqrt{\frac{Q+q}{q}}$, in which Q is the amount of heat set free at the moment of chemical combination ; q, 273 times the specific heat ; θ_1, the velocity of explosive translation of gaseous molecules ; θ_0, the velocity of mean translation after the explosive wave has ceased to exert any influence. They have verified the formula approximately, for a score of gaseous mixtures of very various compositions. They think that in the act of explosion a certain number of molecules are thrown forward with all the velocity corresponding to the maximum temperature developed by the chemical combination ; this movement is transmitted from one inflamed edge to another, in a wave which is propagated with a velocity either identical, or comparable, to that of the molecules themselves.

Introduction to a Study of the North American Noctuidæ. By A. R. Grote, A. M.

(Read before the American Philosophical Society, June 16, 1883.)

In my "List of the Noctuidæ," 1874, the "Check Lists" of 1876 and 1882, my "Illustrated Essay" and a number of different papers, I have explained the characters of *Noctuidæ*, a family of moths of nocturnal habit and of very general distribution. These structural features, which are used in establishing genera and other divisions are briefly summarized as follows, taking the three divisions of the body in turn :

I. The *Head :* character and structure of the compound eyes, which are either full or ovate, small, large, or more or less constricted, and have their surface naked or studded with hair, and the orbits sometimes provided with longer hair, dependent over the eye and called *lashes ;* the character and structure of the clypeus or front, between the eyes, which is swollen or flat and sometimes provided with a tubercle, or horns of various shapes and sizes, or a depression ; the presence of ocelli ; the shape and size of palpi and tongue ; the vestiture of the different parts.

II. The *Thorax:* the shape of the wings, their squamation and neuration; the structure of the feet, the tibiæ being variously spined, or armed with claws, or again unarmed, the tarsi which are always spinose show a variation in the character of the spines; the shoulder covers or patagia may be either deflected or closely applied; the collar which varies in size and shape.

III. The *Abdomen:* its comparative length and form; the male genitalia which vary in shape, the female ovipositor may be protruded or not.

General characters may be drawn from the vestiture and tuftings along the dorsal lines of the body. The clothing of the thorax varies from hairy to being composed wholly of flattened scales. I have also used the infraclypeal plate at the base of the "front," which is variously produced and in *Rhodosea* seems slightly mesially projected. Comparative characters are offered by the size of the appendages, width of clypeus, the retraction or projection of the head. Secondary sexual characters are to be used as of generic value when they are of such a nature, that if shared by both sexes they would be held sufficient to found a genus upon. This would exclude the antennæ from their variability, so far as the usual pectinations are concerned, but admits such abnormal male characters as are offered in the antennæ of the genera *Renia, Syllectra*, etc.; also the genitalia, upon which sections may be founded, but which do not seem to be sufficiently stable in their modifications to form part of the diagnosis. The color and pattern of ornamentation often give a clue to the affinities of a species and, in my opinion, should not be entirely disregarded, but afford no ground by themselves to establish any structural group. The immature stages, egg, larva and chrysalis should also be studied, and they will often give a certainty as to the location of a form not to be attained in any other way. Unfortunately they are generally unknown; on this account alone our classification is provisional and it must remain so to a greater or less extent so long as the natural history of the family is not completely known and studied.

The family *Noctuidæ*, then, may be said to contain moths, having 12-veined forewings, of which vein 5 belongs to the series attached to the median vein, being nearer vein 4 than vein 6, except in the genus *Nolaphana*, where it seems to be nearly central in its location, and having two internal free veins on the hindwings. This latter character divides them from the *Pyralidæ*, a family which the lower genera of the *Noctuidæ* approach in general form. The former character separates them from the *Geometridæ*, a family which is lower and next succeeds the *Noctuidæ*, as may be seen from the fact that the larval form which is characteristic of the *Geometridæ* only obtains in certain lower genera of *Noctuidæ*, which, in the perfect stage, also show a tendency (*Homoptera*) to copy the position of the wings in repose, and the ornamentation habitual with the *Geometridæ*. The wings in the *Noctuidæ* are entire, except in *Eulintneria*, in which genus the male has a slip on the external margin, a secondary sexual character of generic value. They have a simple frenulum in the

males, which is divided (not "double") in the females. The wings may be said to be short and narrow; they broaden in the lower genera and again in some genera may be said to be long in comparison with the body (*i. e.*, *Cucullia*, etc.). The ocelli are almost always present, while in the *Geometridæ* they are almost always absent. The palpi lengthen as we descend to the lower genera, where they assume unusual shapes as in *Palthis*. The male antennæ are ciliate, bristled, brush-like or toothed and pectinate, the female antennæ being almost always simpler in structure; *Renia*, *Zanclognatha*, and other genera have them furnished with tufts, coils of hair or nodosities. The "front," or clypeus, is broad and square as compared with either the *Geometridæ* or *Pyralidæ*. The maxillary palpi are short and concealed. The tongue is equally stout, but occasionally short, weak or rudimentary. The eyes are full, and may be either naked or hairy, the hairs being weak and short in *Trichocosmia*, but usually prominent as in *Mamestra*. The orbit of the eye is furnished with a more or less complete circle of hair in some genera, and there is often a circle of discolorous scales lying back from the orbit. The vertex of the head is sometimes clothed with scales, differing in shape and position from those on the "front," which are often short and converge mossily about a central protuberance varying in character. The thorax is short and stout, thickly scaled and often tufted on the dorsal line, with the tufts divided in some genera, and more or less lengthy and peculiar. The metathorax is short; the middle region of the body is well developed as compared with the other families and muscular, the base of the wings and their framework of veins being usually stout and stiff; the flight is most often strong and rapid, and approaches that of the *Sphingidæ*. The habit of hovering over flowers is characteristic of certain genera such as *Plusia*. The abdomen is conical, and usually exceeds the hind wings, the contour is definite; it is variously tufted, or again smooth or with a carina on the dorsal line; again it is flattened, seldom weak or short.

The colors are brown and gray. The hind wings are quite highly colored, but, as a rule, simple and slight in their markings as compared with the fore wings; oftenest they are quite plain or with one or two cloudy lines parallel with the outer margin and a discal spot. The fore wings are usually distinctly lined. They have a basal half-line (b. h. l.), an inner median or transverse anterior (t. a.) line, a median shade (m. s.), an outer median or transverse posterior (t. p.) line, a subterminal line (s. l.), a terminal line (t. l.) at the base of the fringes. There are three stigmata: the *orbicular*, a rounded anterior spot on the cell; the *reniform*, a usually kidney-shaped spot outward the cell; the *claviform*, a pointed spot attached to the t. a. line below the orbicular. In the genus *Catocala* there is also a subreniform spot, while the claviform is absent. The typical ornamentation is displayed in such genera as *Hadena* and *Mamestra*. Almost always it can be made out and its presence renders a description recognizable if drawn up with care, and the different lines and spots, which are thus easily executed, fully and

comparatively described. The descriptions in French of M. Guenée seem to me very good as a rule, and, as a consequence, but few of his North American species are in doubt. A study of the ornamentation of the *Noctuidæ* is interesting. In related species I found that the differences showed themselves first on upper surface of primaries, then of secondaries, lastly, beneath.

I only mention the genus *Catocala* now to refer to a paper, published by me some twelve years ago, in which I identified one species previously described, and in order to recall the fact that I showed that the origin of the subreniform spot to be the outer median (transverse posterior) line itself. It here set back a sulcation which became gradually separated from the line, and in some species now appears as an almost round spot without any connection with its point of origin. In like manner I conceive the stigmata to have originated. The reniform probably form the median shade, the orbicular and claviform form the inner median (t. a.) line. The spots are then developments from the transverse lines, although it may not be certain whether the reniform is not a relic of a former band, or perhaps of the outer line, though this is not so probable, judging from the course of the median shade, which, in some species, seems to be interrupted by the reniform. Every one has read or should read the best chapter in Mr. Scudder's book on butterflies, that on classification and origin, and will remember his theory of the primitive style of marking, a succession of lines following the shape of the outer margin. It seems quite exact to me from my previous studies of the markings of the *Noctuidæ*. It also works in with my conclusions as to the law of variation in this group, which I showed affected the upper surface of fore wings first, then the hind wings, and then the under surface, following the exposure of the surface, to the light and air.

From these characters we may offer the following *résumé* by which the student may recognize a Noctuid. The front is square and broad, the labial palpi are divergent and prominent, obliquely ascending, the second joint longest and thickly pilose, the ocelli are present, the eyes are full, the tongue stout, the maxillary palpi concealed, the antennæ thread-like, ciliate or brush-like, rarely pectinate in the males. The thorax is heavy and stout, the prothorax broad and distinct, the patagia relieved, the metathorax very short, the flanks broad; the wings stiff, strong and short, the secondaries plain, covered by the fore wings in repose, the primaries 12, the secondaries 8 veined, the latter with two internal veins counted as one; the legs are strong, tarsi spinose, tibiæ sometimes with claws or spines. The abdomen is conical, and exceeds the hind wings, its contour defined. The vestiture is hairy or mixed with flattened scales, usually dense.

The *form* of the *Noctuidæ* (as insisted on by Agassiz as a family character), united three structurally distinct groups, regarded as families by Lederer. The first of these is represented in our fauna by a few species, and is nowhere numerous. No name hitherto employed for it is tenable

under an amended nomenclature. Dr. Harvey and Dr. Packard have shown that the term *Cymatophora* is to be applied to a genus of *Geometridæ*. The terms *Bombycidæ* and *Noctuobombycini* have not a proper form. Only one of the genera comprising it is beyond dispute, and is represented in Europe, Asia and America by distinct species, viz.: *Thyatira*. I shall call this group, then, *Thyatiridæ*. It differs by the course of vein 8 of the secondaries, and the position of vein 5 of the primaries from all the rest of the *Noctuidæ*. The second family is the *Noctuidæ* proper. It contains subfamilies, which I have designated in my "New Check List," and which I discuss here so far as the present paper extends. Other writers have seen in it three principal groups, the *Non-fasciatæ* of Borkhausen (= *Noctuinæ* of Packard) and the *Fasciatæ* (= *Catocalinæ* Pack.); also the *Deltoides* of Latreille, so called from the wings in repose forming the outline of the Greek letter Delta (Δ). At the time of writing his paper, Dr. Packard seems to have regarded the latter as *Pyralidæ*. It is not possible to separate them from the lower *Noctuidæ* as shown by Dr. Herrick-Schæffer. They fall into two subfamily groups: the *Herminiinæ* and *Hypeninæ*. The differences between these groups are a mere extension of the general comparative characters by which smaller assemblages of genera may be defined. I have restricted Dr. Packard's terms to two special groups of smaller extent, and these I believe to have an equivalent value to his subfamily groups in the *Geometridæ*, and which I have discussed above. We have then in the Noctuidæ primarily three families:

I. THYATIRIDÆ.
II. NOCTUIDÆ.
III. BREPHIDÆ.

This last, again, a group of very limited extent, destitute of ocelli, broad winged and hirsute, has vein 5 midway between 4 and 6, but differing by the neuration of secondaries from the THYATIRIDÆ.

In the *Thyatiridæ* no subfamily groups seem to me recognizable since the discovery of our Western forms, *Thyatira Lorata* and *Bombycia semicircularis*. At first sight the genera *Leptina* and *Bombycia* (= *Cymatophora*), and again the genera *Thyatira*, *Pseudothyatira* and *Habrosyne* (= *Gonophora*) seem to afford two series which in the European fauna appear distinguishable. Hubner was the first to associate these genera, some of the earlier European writers classifying *Thyatira* with *Plusia*. In our fauna *Pseudothyatira* stands nearest to *Habrosyne*, while our species of *Thyatira* approach our two *Bombycide* in several respects.

The general characters of the moths of the *Noctuidæ* I have thus gone over quite fully, and I now mention those of the subfamily groups, after a few remarks which suggest themselves to me, since I finally deal with the subject after a quarter of century of more or less continuous study of it. As to nomenclature, the Preface to Staudinger and Wocke's Catalogue seems to me to give the most practical and feasible rules whereby the choice of names is to be regulated. There should be a uniformity in

family and subfamily terminations, and I am finally opposed to the barbarous names used by Mr. Scudder for these groups in the butterflies.

There is a certain amount of natural error which a student may fall into while gradually becoming acquainted with a large amount of new and differing species, as to which no work was before him, and through which he had to break a path. All things considered, no one in my position could have escaped having to change his views and cancel some of his work. I have always quickly acknowledged and corrected my mistakes, as all who have followed and used my previous writings, I think, admit.

With these explanatory remarks, I would now offer a *résumé* of my conclusion and studies on the family.

It must be acknowledged that the *Noctuidæ* are difficult of limitation as a family by exclusive characters. They may be shown to differ in turn in single points from other family groups of moths, but certain genera in every fauna are difficult to place. As to subfamilies, Lederer shows that these can only be defined comparatively, and not exactly, or, as he calls it, scientifically. The groups here recognized are merely tentative associations of genera to which I have given a subfamily name; they contain all of them genera which may be displaced by future enquiries, but they help the comprehension of the family and enable us to consider certain assemblages together. As to their names, I have not followed any rule of priority; Guenée gives some of them a family form. I have given them a uniform termination, and derived them from the most prominent genus they contain.

The summer, that pulse of the year, the length of whose recurring beat is at once the measure of the time elapsed since the culmination of the last ice period, gives us a prevailing northward direction for the winds that sweep the North American Continent. These offer ærial paths along which numbers of feathery-winged moths are hurried. We have wind visitors from the West Indies upon our shores during the whole season. Some of these become partial citizens by breeding here, others do not, and their lodgment upon our territory is precarious and accidental. The list of species known to visit us in this manner is already somewhat extensive, while the southern part of the peninsula of Florida is occupied permanently by the assemblage of tropical insects. This subject leads us to consider briefly the distribution of our *Noctuidæ*.

The *Geographical Distribution* of the North American *Noctuidæ* must be studied in connection with the topography of the country and the range of the food-plants of the caterpillar. It is found that mountain chains afford the most effective barrier to the distribution of species. Their presence explains the fact that Ohio insects are often absent in New York, or not so abundant on the north and east of the Alleghanies. A study of the ranges and lateral branches of the Rocky mountains, as they are delineated, gives an idea of the different faunal provinces which are discovered to be more or less restricted to the valleys between the spurs. It is shown that, often at short distances in this region, the character of the moths in

adjacent valleys changes. We have essentially one fauna, which is arrested at the St. John's river by a tropical colony inhabiting Southern Florida. The Labrador fauna is a true extension of the Canadian, and the *Noctuidæ* of that region may be found again inhabiting the sides of Mount Washington. I disagree then with Staudinger, who includes the Labrador with the European fauna, believing him to be misled by the identity of alpine species with our more northern forms. On the west our fauna extends downwards along the table-lands occupying the centre of the Mexican peninsula, the hot and low lands on either side being occupied by a different and tropical fauna. Singularly enough some more northern west coast species have been found in Maine and Canada. There must be a northern outlet in the mountain ranges of the Pacific coast. The principal feature in the distribution of our fauna is the migrations. A yearly zoölogical wave sets in from Mexico and the West Indies, and carries on its crest a number of light-winged *Noctuidæ*, which eventually range up our entire coast, and are found in Maine in the fall. The most important to us of these species is the cotton worm, which I have studied a long time. This moth, which feeds on the perennial cotton of South and Central America, must have visited our mainland for years before the cultivation of our annual cotton gave it a lodgment on our soil. Now it increases by the rich fields offered as food for its larva, and traverses the country in successive broods from the South to the Ohio river. Beyond this it flies, but it is doubtful that it again accomplishes its transformations on a substitute food-plant in the fall. The probability is that it does. I originally showed that, in the South, it would feed on nothing but cotton, from my observations and experiments. I find now that Prof Riley occupies my ground, and states that it *only* feeds on cotton and that its northern journey is fruitless. I originally discovered that the whole inquiry, from an economical point of view, hinged upon the discovery of its successful hibernation, after being the first to positively ascertain that it wintered as a moth

In my paper (1874) I suggested that this might still be extra limital or confined to a narrow southern strip of land in Texas or Florida. In this I was probably mistaken, and it may be that it has a hold throughout the cotton belt. But I wish to point out distinctly that this was the matter to be ascertained, and that my theory is to-day the correct one. It showed that the area of successful hibernation was the point for future enquiry, and I suggested in the *Tribune* the means to get this information, and the preventive measures to be employed, if this region was such as could be dealt with by preventive measures in the spring. As to its extra limital origin, Professor Riley finds a short letter anticipating my theory, but necessarily presenting few facts as the range of North American *Noctuidæ* was not then known. However this may be, neither Prof. Riley nor I knew of this letter, when I read my paper in 1874, five years after I had formed my conclusions To suggest that my theme was not original, is to deal unfairly with the facts. I have shown that Prof. Riley did not

study the cotton worm in connection with the cotton plant. I protest against his Cotton Worm Report as doing me throughout grave injustice. I find even the moths which I named for Professor Baird, which were mistaken for cotton moths by unskilled observers, recapitulated in this report, in which my observation as to the larval feet of *Aletia* and *Anomis* is appropriated. I have named moths for Prof. Riley for twenty years. He even lately tries to make me responsible for his re-description of the "Corn-bud Worm" of Abbott and Smith, the *Laphygma frugiperda* of authors, as a new *Prodenia autumnalis* Riley; and quotes a fragment of a private letter of mine to substantiate the charge. But I never saw the moths till after he had named them, and my letter merely acknowledges the specimens, and gives no opinion on the matter. Since 1864 I knew Abbot's work thoroughly, as shown by my writings on the *Sphingidæ*, and my identification of his species.

As to practical Entomology I allow myself here to express an opinion founded on my experience. The reports of State entomologists often reiterate a good deal, and do not seem to reach the farmers for whom they are intended. An inquiry about the way in which the money of the United States Entomological Commission has been spent with the results attained will show, I am confident, that the facts it has published have not reached the great body of American agriculturists, the principal parties interested.

The system of State entomologists must be changed, and these officials should lecture before the public schools and institute meetings in the county districts, and thus bring the outlines of entomology and a knowledge of common pests before the young. In this way farmer boys will learn to respect robins' nests and pull down the nests of the tent caterpillar instead. As matters are now, it is little use of one man's cleaning out his orchard while another next door keeps a breeding place for the codling moth. Public education must take charge of the matter, and there will then be a prospect of saving much that is now wasted. From a perusal of Mr. Wm. Saunders' excellent book* on "Insects Injurious to Fruit Trees," it is plain that personal labor and mechanical appliances for jarring and gathering or crushing are better than poisons in most cases, and I reiterate here the opinion I expressed at the Saratoga meeting of the American Association, that the use of Paris green is to be deprecated from the liability of poisoning to stock, and the persons handling it, to say nothing of its criminal use which has not unfrequently happened.

In the following arrangement I have given our *Thyatiridæ* and the bulk of the *Noctuidæ* down to the *Catocalinæ* and *Deltoids*. All the genera are here cited, but I have only given the species described by myself as a rule; the other species are cited in my "New Check List," and do not usually give different characters from those here presented, which I have

* This work (which should be used in public schools), from its admirably simple and correct style, its illustrations and arrangement of material used, is entitled to be regarded as the best on the subject since the now classical treatise of the late Dr. Harris.

specially studied. I have also omitted the synonyms and subgenera. I follow this list by a discussion of the twenty-four groups into which I have divided the genera, and conclude the paper by special generic descriptions.

I trust this paper will be of general service to the student, and it is offered as my probably final contribution to a knowledge of this interesting group. The paper was written for the most part several months ago, and was intended to be of wider extent, and include some plates which I cannot now give.

SYSTEMA NOCTUIDÆ AMERICÆ BOREALIS.

I. THYATIRIDÆ.

Habrosyne Hubn.
Scripta *Gosse.*
Pseudothyatira m.
Cymatophoroides *Guen.*
var. Expultrix *m.*
Thyatira Ochs.
Pudens *Guen.*
Lorata *m.*
Bombycia Hubn.
Semicircularis *m.*
Improvisa *Hy. Edw.*
Leptina Guen.
Ophthalmica *Guen.*
Australis *m.*
Doubledayi *Guen.*
Dormitans *Guen.*
Latebricola *m.*

II. NOCTUIDÆ.

1. *Dicopinæ.*
Eutolype m.
Rolandi *m*
Dicopis m.
Muralis *m.*
Viridescens *Walk.*
Electilis *Morr.*
Depilis *m.*
Thaxterianus *m.*
Damalis *m.*
Copipanolis m.
Cubilis *m.*

2. *Apatelinæ.*
Andela Walk.
Acromyctoides *Walk.*
Platycerura Pack.
Furcilla *Pack.*
Charadra Walk.
Propinquilinea *m.*
Deridens *Guen.*
Dispulsa *Morr.*
Palata *m.*
Raphia Hubn.
Abrupta *m.*
Frater *m.*
Feralia m.
Jocosa *Guen.*
Momaphana m.
Comstocki *m.*
Diphthera Hubn.
Fallax H.-S.
Apatela Hubn.
Occidentalis *G. and R.*
Morula *G. and R.*
Thoracica *m.*
Falcula *m.*
Parallela *m.*
Albarufa *m.*
Paupercula *m.*
Vinnula *m.*
Quadrata *m.*
Tota *m.*
Americana *Harr.*
Dactylina *m.*
Spinea *m.*
Lupini *m.*

Vulpina *m.*
Felina *m.*
Luteicoma *G. and R.*
Distans *m.*
Subochrea *m.*
Noctivaga *m.*
Afflicta *m.*
Connecta *m.*
Harveyana *m.*
Ovata *m.*
Exilis *m.*
Hæsitata *m.*
Dissecta *G. and R.*
Sperata *m.*
Edolata *m.*
Extricata *m.*
Lithospila *m.*
Lanceolaria *m.*
Insolita *m.*

Arsilonche Led.

Henrici *m.*
var. Evanidum *m.*

Copablepharon Harvey.

Absidum *Harvey.*
Album *Harvey.*
Subflavidens *m.*
Longipenne *m.*

Harrisimemna m.

Trisignata *Walk.*

3. *Bryophilinæ.*

Cerma Hubn.

Cora Hubn.

Polygrammate Hubn.

Hebraicum *Hubn.*

Microcœlia Guen.

Fragilis *Guen.*
Diphteroides *Guen.*
var Obliterata *m.*

Bryophila Tr.

Lepidula *m.*

Cyathissa m.

Percara *Morr.*

Chytonix m.

Sensilis *m.*

4. *Noctuinæ.*

Carneades m.

Mœrens *m.*
Citricolor *m.*

Agrotis Hubn.

Badicollis *m.*
Janualis *m.*
Pallidicollis *m.*
Opacifrons *m.*
Perattenta *m.*
Attenta *m.*
Stellaris *m.*
Phyllophora *m.*
Rubifera *m.*
Perconflua *m.*
Rosaria *m.*
Planalis *m.*
Hospitalis *m.*
Viralis *m.*
Esurialis *m.*
Quarta *m.*
Apposita *m.*
Fishii *m.*
Normaniana *m.*
Conchis *m.*
Mirabilis *m.*
Innotabilis *m.*
Washingtoniensis *m.*
Treatii *m.*
Juncta *m.*
Haruspica *m.*
Muscosa *m.*
Invenusta *m.*
Terrealis *m.*
Mercenaria *m.*
Auxiliaris *m.*
var. Agrestis *m.*
var. Introferens *m.*
Perexcellens *m.*
Gularis *m.*
Immixta *m.*
Docilis *m.*
Evanidalis *m.*
Herilis *m.*
Vittifrons *m.*

Insularis *m.*
Costata *m.*
Idahoensis *m.*
Formalis *m.*
Facula *m.*
Emarginata *m.*
Observabilis *m.*
Bimarginalis *m.*
Bicollaris *m.*
Lætula *m.*
Cupida *m.*
var. **Brunneipennis** *m.*
var. **Alternata** *m.*
var. **Cupidissima** *m.*
var. ? **Orbis** *m.*
Variata *m.*
Minimalis *m.*
Placida *m.*
Discoidalis *m.*
Brunneicollis *m.*
Havilæ *m.*
Murænula *G. and R.*
Dolis *m.*
Dapsilis *m.*
Catenula *m.*
Atrifera *m.*
Vernilis *m.*
Euroides *m.*
Milleri *m.*
Vocalis *m.*
Hollemani *m.*
Silens *m.*
Albalis *m.*
Cloanthoides *m.*
Infimatis *m.*
Lagena *m.*
Pluralis *m.*
Pleuritica *m.*
Pitychrous *m.*
Niveivenosa *m.*
Niveilinea *m.*
Olivalis *m.*
Quadridentata *G. and R.*
Cicatricosa *G. and R.*
Ridingsiana *m.*
Lewisii *m.*
Versipellis *m.*
Colata *m.*
Declarata *Walk.*
var. **Campestris** *m.*
var. **Decolor** *Morr.*
var. **Albipennis** *m.*
var. **Nigripennis** *m.*
Verticalis *m.*
Tessellata *Harris.*
var. **Atropurpurea** *m.*
Tesselloides *m.*
Strigilis *m.*
Geniculata *G. and R.*
Collaris *G. and R.*
Badinodis *m.*
Bollii *m.*
Atrifrons *m.*
Piscipellis *m.*
Grandipennis *m.*
Perfusca *m.*
Velleripennis *m.*
Pastoralis *m.*
Balinitis *m.*
Friabilis *m.*
Fuscigera *m.*
Brunneigera *m.*
Rubefactalis *m.*
Micronyx *m.*
Fumalis *m.*
Dollii *m.*
Eriensis *m.*
Worthingtoni *m.*
Sublatis *m.*
Munis *m.*
Violaris *G. and R.*
Wilsonii *m.*
Specialis *m.*
Basalis *m.*
Mimallonis *m.*
Gagates *m.*
Catherina *m.*
Circumdata *m.*
Vancouverensis *m.*
Semiclavata *m.*
Gravis *m.*
Vapularis *m.*

Æneipennis *m.*
Nanalis *m.*
Clodiana *m.*
Texana *m.*
Pellucidalis *m.*
Beata *m.*
Cœnis *m.*
Nigrovittata *m.*
Trabulis *m.*
Pressa *m.*

Anytus m.

Sculptus *m.*
var. Planus *m.*

Ammoconia Led.

Decipiens *m.*
var. Parentalis *m.*
Distichoides *m.*

Adita m.

Chionanthi *A. and S.*

Eucoptocnemis m.

Fimbriaris *Guen.*

Agrotiphila m.

Montana *Morr.*
Crotchii *m.*
Chartaria *m.*
Defersa *m.*
Bella *m.*
Pensilis *m.*
Vicina *m.*
Acutipennis *m.*
Gnata *m.*
Glaciata *m.*
Cuneata *m.*
Quadrilineata *m.*
Alboguttata *m.*
Comis *m.*
Sutrina *m.*
Lustralis *m.*
Meditata *m.*
Innexa *m.*
Spiculosa *m.*
Ferrealis *m.*
Cinnabarina *m.*
var. Ferrea *m.*
Niveiguttata *m.*
Leucogramma *m.*
Insolens *m,*
♂ *Arietis* m.

5. *Hadeninæ.*

Fishia m.

Euthea *m.*

Copimamestra m.

Occidenta *m.*

Mamestra Ochs.

Purpurissata *m.*
Discalis *m.*
Lubens *m.*
Beanii *m.*
Legitima *m.*
Liquida *m.*
Noverca *m.*
Goodellii *m.*
Vittula *m.*
Farnhamii *m.*
Nevadæ *m.*
Subjuncta *G. and R.*
Atlantica *m.*
Dimmockii *m.*
Bisulca *m.*

Trichoclea m.

Decepta *m.*

Luceria Von Hein.

Delicata *m.*

Hadena Schrank.

Ducta *m.*
Separans *m.*
Occidens *m*
Bridghamii *G. and R.*
Violacea *m.*
Hulstii *m.*
Sputatrix *m.*
Plutonia *m.*
Vultuosa *m.*
Cristata *m.*
Lignicolor *Guen.*
var. Quæsita *m.*
Genialis *m.*
Auranticolor *m.*
Cuculliiformis *m.*

Vulgaris *G. and R.*
Idonea *m.*
Semilunata *m.*
Discors *m.*
Perpensa *m.*
Cinefacta *m.*
Leucoscelis *m.*
Olorina *m.*
Hillii *m.*
Indirecta *m.*
Tusa *m.*
Tonsa *m.*
Chryselectra *m.*
Charactra *m.*
Genetrix *m.*
Adnixa *m.*
Fumosa *m.*
Longula *m.*
Diversilineata *m.*
Tortilis *m.*
Marina *m.*
Misera *m.*
Cylindrica *m.*
Vulgivaga *Morr.*
Fractilinea *m.*
var. præc.?
Modiola *m.*
var. præc.?
Hausta *m.*
Pseudanarta Hy. Edw.
Crocea *Hy. Edw.*
Flava *m.*
Singula *m.*
Flavidens *m.*
Aurea *m.*
Oligia Hubn.
Chalcedonia *Hubn.*
var. Tracta *m.*
Versicolor *m.*
Fuscimacula *m.*
Perigea Guen.
Epopea *Cramer.*
Cupentia Cram.
Infelix Guen.
Confederata m.
Condica Palpalis Walk.

Iole *m.*
Xanthioides *Guen.*
var. Enixa *m*, pall.
Luxa *m.*
Falsa *m.*
Albolabes *m.*
Loculosa *m.*
Vecors *Guen.*
Lussa m.
Nigroguttata *m.*
Dipterygia Steph.
Scabriuscula *Linn.*
Hyppa Dup.
Xylinoides *Guen.*
Hillia m.
Senescens *m.*
Vigilans *m.*
Algens *m.*
Valeria Germ.
Opina *m.*
? Conserta *m.*
Dryobota Led.
Stigmata *m.*
Arthrochlora m.
Februalis *m.*
Copivaleria m.
Grotei *Morr.*
Oncocnemis Led.
Hayesi *m.*
Dayi *m.*
Mirificalis *m.*
Behrensi *m.*
Levis *m.*
Pernotata *m.*
Glennyi *m.*
Homogena *m.*
Oblita *m.*
Augustus *Harvey.*
Chandleri *m.*
Riparia *Morr.*
Major *m.*
Aqualis *m.*
Curvicollis *m.*
Cibalis *m.*
Gracillima *m.*
Saundersiana *m.*

Occata *m.*
Atricollaris *Harvey.*
Atrifasciata *Morr.*
Griseicollis *m.*
Aterrima *m.*

Homohadena m.
Chorda *m.*
Badistriga *m.*
Vulnerea *m.*
Kappa *m.*
Figurata *Harvey.*
Epipaschia *m.*
Induta *Harvey.*
Incomitata *Harvey.*
Inconstans *m.*
Fortis *m.*
var. ? Picina *m.*

Aporophyla Guen.
? Yosemitæ *m.*

Trichopolia m.
Dentatella *m.*
Ptilodonta *m.*

Pachypolia m.
Atricornis *m.*

Polia Fr.
Acutissima *m.*
Medialis *m.*
Illepida *m.*
Pallifera *m.*
Ædon *m.*
Theodori *m.*
Epichysis *m.*

Hadenella m.
Pergentilis *m.*

Actinolia Hubn.
Ramosula *Guen.*
Stewarti *m.*

Callopistria Hubn.
Strena *m.*

Laphygma Guen.
Frugiperda *A. and S.*

Prodenia Guen.
Commelinæ *A. and S.*
Præfica *m.*

Eupsephopæctes m.
Procinctus *m.*

Conservula m.
Anadonta *Guen.*

Trigonophora Hubn.
Periculosa *Guen.*
var. V-brunneum *m.*

Euplexia Steph.
Lucipara *Linn.*

Brotolomia Led.
Iris *Guen.*

Nephelodes Guen.
Minians *Guen.*
var. Violans *Guen.*

Tricholita m.
Semiaperta *Morr.*
Fistula *Harv.*
Inconspicua *m.*

Admetovis m.
Oxymorus *m.*

Helotropha Led.
Reniformis *m.*
var. Atra *m.*
Sera *G. and R.*

Apamea Tr.
Purpuripennis *m.*
Nictitans *Bkh.*
Juvenilis *m.*
Erepta *m.*

Gortyna Hubn.
Inquæsita *G. and R.*
Cerina *m.*
Rigida *m.*
Cataphracta *m.*
Impecuniosa *m.*
Purpurifascia *G. and R.*
Harrisii *m.*
Speciosissima *G. and R.*
Cerussata *m.*
Necopina *m.*
Serrata *m.*

Ochria Hubn.
Sauzalitæ *m.*
Buffaloensis *m.*

Achatodes Guen.
Zeæ *Harris.*

Macronoctua m.
Onusta *m.*

Euthisanotia Hubn.
Timais *Cram.*
Lathosea m.
Pulla *m.*

6. *Arzaminæ.*

Sphida m.
Obliquata *G. and R.*
Arzama Walk.
Densa *Walk.*
Vulnifica *m.*
Melanopyga *m.*
Diffusa *m.*

7. *Nonagriinæ.*

Nonagria Ochs.
Permagna *m.*
Subflava *m.*
Oblonga *m.*
Tota m.
Armata *m.*
Minorata *m.*
Senta Steph.
Defecta *m.*
Platysenta m.
Atriciliata *m.*
Angustiorata *m.*
Tapinostola Led.
Orientalis *m.*
Ommatostola m.
Lintneri *m.*
Heliophila Hubn.
Oxygala *m.*
Prægracilis *m.*
Patricia *m.*
Bicolorata *m.*
Rubripennis *G. and R.*
Ligata *m.*
Dia *m.*
Lapidaria *m.*
Adjuta *m.*
Farcta *m.*
Adonea *m.*
Flabilis *m.*
Rimosa *m.*
Pseudargyria *Guen.*
var. Callida *m.*
Zosteropoda *m.*
Hirtipes *m.*
Ufeus m.
Satyricus *m.*
Plicatus *m.*
Unicolor *m.*
Sagittarius *m.*
Pteroscia Morr.
Atrata *Morr.*

8. *Scolecocampinæ.*

Scolecocampa Guen.
Liburna *Geyer.*
Eucalyptera Morr.
Bipuncta *Morr.*
Obscura *m.*
Doryodes Guen.
Bistriaris *Geyer.*
Phiprosopus m.
Callitrichoides *m.*
Amolita m.
Fessa *m.*
Cilla m.
Distema *m.*

9. *Nolaphaninæ.*

Nolophana *m.*
Malana *Fitch.*
Triquetrana *Fitch.*
Zelleri *m.*
Labecula *m.*
Adipsophanes m.
Miscellus *m.*
Crambodes Guen.
Talidiformis *Guen.*

10. *Caradrinæ.*

Fotella m.
Notalis *m.*
Caradrina Tr.
Miranda *m.*

Fragosa *m.*
Civica *m.*

Pyrophila Hubn.
Tragopoginis (Linn.).
Triquetra *m.*

11. *Tæniocampinæ.*

Orthodes Guen.
Nitens *m.*

Himella m.
Intractata (*Morr.*).

Tæniocampa Guen.
Agrotiformis *m.*
Virgula *m.*
Furfurata *m.*
Peredia *m.*
Rufula *m.*
Puerilis *m.*
Perbrunnea *m.*
Consopita *m.*
Garmani *m.*

Perigrapha Led.
Normalis *m.*
Muricina *m.*
Behrensiana *m.*
Plusiiformis *Hy. Edw.*
Erythrolita *m.*
Transparens *m.*
Præses *m.*

Crocigrapha m.
Normani *m.*

Xylomiges Guen.
Hiemalis *m.*
Curialis *m.*
Patalis *m.*
Tabulata *m.*
Perlubens *m.*
Dolosa *m.*

Morrisonia m.
Evicta *m.*
var. Vomerina *m.*
Infidelis *m.*

Anchocelis Guen.
Digitalis *m.*

Parastichtis Hubn.
Gentilis *m.*
var. Perbellis *m.*

12. *Orthosiinæ.*

Metalepsis m.
Cornuta *m.*

Pachnobia Guen.
Carnea *Thunb.*

Trichorthosia m.
Parallela *m.*

Pseudorthoria m.
Variabilis *m.*
Pectinata *m.*

Choephora G. and R.
Fungorum *G. and R.*

Pseudoglæa m.
Tædata *m.*
Blanda *m.*
Decepta *m.*

Zotheca m.
Tranquilla *m.*
var. Viridula *m.*
var. Viridifera *m.*

Cea m.
Immacula *m.*

Calymnia Hubn.
Orina *Guen.*

Trichocosmia m.
Inornata *m.*

Ipimorpha Hubn.
Pleonectusa *m.*
var. Subvexa *m.*

Orthosia Ochs.
Purpurea *m.*
Crispa *Harvey.*
Decipiens *m.*
Ralla *G. and R.*
Euroa *G. and R.*
Inops *m.*
Helva *m.*
Conradi *m.*
Citima *m.*

Cosmia Hubn.
Infumata *m.*

Homoglæa Morr
Hircina *Morr.*
Carnosa *m.*
Glæa Hubn.
Viasica *m.*
Inulta *m.*
Epiglæa m.
Apiata *m.*
Decliva *m.*
Deleta m.
Jodia Hubn.
Rufago *Hubn.*
Eucirrœdia m.
Pampina (*Guen.*)
Scoliopteryx Germ.
Libatrix *Linn*
Xanthia Hubn.
Togata *Esper.*
Scopelosoma Curtis.
Pettiti *m.*
Græfiana *m.*
Moffatiana *m.*
Ceromatica *m.*
Devia *m.*
Morrisoni *m.*
Vinulenta *m.*
Sidus *Guen.*
var. Walkeri *m.*
Tristigmata *m.*
Litholomia m.
Napæa (*Morr.*).
Lithophane Hubn.
Hemina *m.*
Petulca *m.*
Gausapata *m.*
Ferrealis *m.*
Bettumei *G. and R.*
Oriunda *m.*
Semiusta *m.*
Contenta *m.*
Georgii *m.*
Antennata *Walk.*
Cinerea Riley.
Laticinerea *m.*
Grotei *Riley.*
Cinerosa | m.
Unimoda *Lintn.*
Tepida *m.*
Baileyi *m.*
Querquera *m.*
Viridipallens *m.*
Pexata *m.*
var. Washingtoniana *m.*
Thaxteri *m.*
Capax *G. and R.*
Lithomia Hubn.
Germana *Morr.*
Calocampa Steph.
Cineritia *m.*

13. *Cuculliinæ.*

Cucullia Schrank.
Convexipennis *G. and R.*
Montanæ *m.*
Cita *m.*
Serraticornis *Lintn.*
Cleophana Boisd.
Eulepis *m.*
Nyctophæata Smith.
Magdalena *Hulst.*

14. *Eurhipiinæ.*

Ripogenus m.
Pulcherrimus *m.*
Marasmalus m.
Ventilator *m.*
Histrio *m.*

15. *Ingurinæ.*

Ingura Guen.
Declinata *m.*
Præpilata *m.*
Flabella *m.*
Oculatrix *Guen.*

16. *Anomiinæ.*

Anomis Hubn.
Erosa *Hubn.*
Exacta *Hubn.*
Aletia Hubn.
Argillacea *Hubn.*

ι *Harvey.*
Pteræstholix m.
la *m.*
Chytoryza m.
m.

17. *Litoprosopinæ.*

Litoprosopus m.
ι *G. and R.*

18. *Calpinæ.*

Calpe Tr.
ensis *Beth.*

19. *Stiriinæ.*

Hypsoropha Hubn.
s *Fabr.*
›s *Hubn.*
Plusiodonta Guen.
·essipalpis *Guen.*
Basilodes Guen.
Guen.
›pis *m.*
Stiria m.
ons *m.*
ırea *Neum.*
Stibadium m.
›sum *m.*
lum *Hy. Edw.*
Chamæclea m.
na *m.*
Cirrhophanus m.
ʒulifer *m.*
Fala m.
phora *m.*
Plagiomimicus m.
·hromus *m.*
lidus *m.*
ri *Morr.*
Acopa Harvey.
ι *Harvey.*
llida *m.*
ι *Hy. Edw.*

Neumœgenia m.
Poetica *m.*

20. *Plusiinæ.*

Diastema Guen.
Tigris *Guen.*
Telesilla H.-S.
Cinereola *Guen.*
Navia *Harv.*
Behrensia m.
Conchiformis *m.*
Abrostola Ochs.
Ovalis *Guen.*
Urentis *Guen.*
Deva Walk.
Purpurigera *Walk.*
Paligera *m.*
Plusia Fabr.
Æreoides *m.*
Metallica *m.*
Contexta *m.*
Putnami *m.*
Striatella *m.*
Formosa *m.*
Mappa *G. and R.*
Dyaus *m.*
Labrosa *m.*
Monodon *m.*
Pseudogamma *m.*
Fratella *m.*
Pedalis *m.*
Viridisignata *m.*
Epigæa *m.*
Sarena *m.*
Pasiphæia *m.*
Sackenii *m.*

21. *Heliothinæ.*

Lepipolys Guen.
Perscripta *Guen.*
Anarta Ochs.
Cordigera *Thunb.*
Luteola *G. and R.*
Quadrilunata *m.*

Nivaria *m.*
Subfuscula *m.*
Submarina *m.*
Sympistis Hubn.
Proprius *Hy. Edw.*
Pseudanthœcia Sm.
Tumida *m.*
Dasypoudæa Sm.
Lucens *Morr.*
var. Luxuriosa *m.*
Meadii *m.*
Euedwardsia m.
Neumœgeni *Hy. Edw.*
Xanthothrix Edw.
Ranunculi *Hy. Edw.*
Axenus m.
Arvalis *m.*
Pseudatamila Sm.
Vanella *m.*
Perminuta *Hy. Edw.*
Heliaca H.-S.
Diminutiva *m.*
Heliosea m.
Pictipennis *m.*
Heliophana m.
Mitis *m.*
Helioloncha m.
Modicella *m.*
Melicleptria Hubn.
Celeris *m.*
Pulchripennis *m.*
Villosa *m.*
Persimilis *m.*
Honesta *m.*
Sueta *m.*
var. Californiensis *m.*
Dysocnemis m.
Belladonna *Hy. Edw.*
Melaporphyria *m.*
Immortua *m.*
Prorupta *m.*
Ononis *Fabr.*
Heliochilus m.
Paradoxus *m.*
Heliothis Hubn.
rmiger *Hubn.*
var. Umbrosus *m.*

Lupatus *m.*
Cupes *m.*
Pyrrhia Hubn.
Angulata *m.*
Stilla *m.*
Oxylos m.
Citrinellus *G. and R.*
Alaria Westw.
Gauræ *A. and S.*
Rhodophora Guen.
Florida *Guen.*
Rhodosea m.
Julia *m.*
Derrinia Walk.
Stellata *Walk.*
var. Henrietta *m.*
Rhododipsa m.
Volupia *Fitch* (m.).
Miniana *m.*
Ædophron Led.
Snowi *m.*
Lygranthœcia G. and R.
Marginata *Haw.*
Rivulosa Guen.
Thoreaui *G. and R.*
Saturata *m.*
Separata *m.*
var. Balba *m.*
var. Acutilinea *m.*
var. ? Coercita *m.*
Velaris *m.*
Tertia *m.*
Limbalis *m.*
Acifera *Guen.*
var. Spraguei *m.*
Brevis *m.*
var. Atrites *m.*
Meskeana *m.*
var. Rufimedia *m.*
Packardii *m.*
Mortua *m.*
Nobilis *m.*
Euleucyptera m.
Cumatilis *m.*
Tennescens *m.*
Tricopis m.
Chrysellus *m.*

Hulotia *Tepper.*
Aleucis *Harv.*
Pippona Harv.
Bimatris *Harv.*
Antaplaga m.
Dimidiata *m.*
Sexseriata *m.*
Grotella Harv.
Septempunctata *Harv.*
Dis *m.*
Oxycnemis m.
Adrena *m.*
Triocnemis m.
Saporis *m.*
Pseudacontia Sm.
Crustaria *Morr.*

22. *Acontiinæ.*

Trichotarache m.
Assimilis *m.*
Tarache Hubn.
Flavipennis *m.*
Abdominalis *m.*
Lanceolata *m.*
Angustipennis *m.*
Sutrix *m.*
Binocula *m.*
Virginalis *m.*
Cretata *G. and R.*
Terminimaculata *m.*
Chamyris *Guen.*
Cerintha Fr.
Xanthodes Guen.
(?) Buxea *m.*
Trileuca m.
Rectifascia *m.*
Gulnare *Streck.*

23. *Eustrotiinæ.*

Lithacodia Hubn.
Bellicula *Hubn.*
Annaphila m.
Diva *m.*
Divinula *m.*
Decia *m.*
Depicta *m.*
Danistica *m.*
Eustrotia Hubn.
Malaca *m.*
Mitographa *m.*
Secta *m.*
Concinnimacula *Guen.*
var. Parvimacula *m.*
Synochitis *G. and R.*
Musta *G. and R.*
Retis *m.*
Distincta *m.*
Caduca *m.*
Mariæ *m.*
Aeria *m.*
Dividua *m.*
Escaria m.
Clauda *m.*
Euherrichia m.
Monetifera *Guen.*
Thalpochares Led.
Ætheria *m.*
Orba *m.*
Fortunata *m.*
Perita *m.*
Tripudia.
Quadrifera *Zell.*
Flavofasciata *m.*
Basicinerea *m.*
Lixiva *m.*
Gyros Hy. Edw.
Muirii *Hy. Edw.*
Spragueia m.
Magnifica *m.*
Plumbifimbriata *m*
Pardalis *m.*
Funeralis *m.*
Sordida *m.*
Guttata *m.*
Inorata *m.*
Fruva m.
Fasciatella *m.*
Obsoleta *m.*
Georgica *m.*
Apicella *m.*

Azenia m.
Implora *m.*
Edentata *m.*
Prothynia Hubn.
Coccineifascia *m.*
Rosalba *m.*
Orgyæ *m.*
Plana *m.*
Xanthoptera Guen.
Nigrofimbria *Guen.*
Clausula *m.*
Exyra m.
Semicrocea *Guen.*
Fax *m.*
Rolandiana *m.*
Lepidomys Guen.
Irrenosa *Guen.*
Metoponia Dup.
Obtusa *H.-S.*
Perflava *Harv.*
Galgula Guen.
Hepara *Guen.*
Subpartita *Guen.*

24. *Hyblæinæ.*

Hyblæa Fabr.
Puera *Fabr.*

1. *Dicopinæ* m. In this section are grouped genera with the head sunken, the squamation rough or thick, the abdomen tending to be weak and plump, as in the *Apatelinæ*, the tibiæ unarmed except by a strong claw on anterior pair, the ocelli present, the male antennæ thick and stoutly pectinate, the eyes naked and lashed, the labial palpi short, the tongue moderate, the chrysalis hibernates, and the moths appear early in the year. As to the ornamentation it is typical in *Dicopis*, and agrees with the *Hadeninæ*. I believe the group to be really close to the latter, and would bring the genera either before or after that group. It does not appear to be represented in Europe. As an instance that natural structural characters are only of subordinate value in arranging the family groups, I would instance the genera *Dicopis*, *Copivaleria*, *Oncocnemis* and *Basilodes*, all have naked eyes, unarmed tibiæ with a claw on anterior pair, yet we cannot associate them in a single group, their general appearance and form is so diverse. *Eutolype* is singular for a small central chalybeous tuft of thoracic scales (easily overlooked and removed when the moth is pinned) only noticeable also in *Tolype* and *Eudryas*; there is a somewhat analogous posterior tuft in *Oxycnemis*. *Copipanolis* is a very singular Bombyciform genus, reddish in color with variably thick median lines, narrower in the female, found from Massachusetts to Texas. There is a faint resemblance to the European genus *Panolis*, but on the whole, I think, a mere analogy.

2. *Apatelinæ* m. This is Boisduval's *Bombycoidea*. The genera are more or less like *Notidontidæ* or *Dasychirinæ* as to moth and larva. The wings are even, the body plump, often the males have pectinate antennæ, though the typical genus was then simple. The larvæ are usually hairy, bristled and bizarre in appearance. *Apatella Funeralis* has club-shaped hairs, and represents in our fauna the European *A. Alni*. *Raphia* is represented by two species, of which the neuration of *Abrupta* seemed to me to agree with that of *R. Hybris*, the European type of the genus which I have never seen. *Charadra* has hairy eyes, and is nearly related, perhaps not distinct. *Audela* and *Platycrura* seem to me related. The term *Diph-*

thera is first used for the European *Aprilina* with which our *D. Fallax* is congenerical, the term *Moma* is incorrectly used for this latter form. For the European *Ludifica*, the term *Trichosea* must be used. The genera *Raphia*, *Charadra* need a re-examination, which now that several species are described can be profitably undertaken. *Apatela* falls into sections which may in some cases have a generic value.

3. *Bryophilinæ* m. The typical genus has flattened scales on the thorax, and is of slight form, the larva feeding on lichens as observed in Europe. The immature stages of our species are not known. *Cyathissa* differs by its narrow form, and an excision below apices of primaries. *Chytonix* is somewhat stouter, with Hadeniform ornamentation; the type was described by Guenée under *Apamea*, but appears to me to be the male form of *Bryophila Palliatricula* Guen. The thorax is scaled; the species are brown with a white sub-median spot attached to t. p. line, or the median field shaded with white. A new title may be necessary for *Cora*, which in many respects is near *Trisignata*. Perhaps only the three last genera belong strictly to this group.

4. *Noctuiinæ* m. This group I place here following Lederer; it seems to me really lower than the *Hadeninæ* and to have affinities with the *Orthosiinæ*. It comprises the typical genus *Agrotis*, with naked, unlashed eyes, untufted abdomen, spinose tibiæ and smoothly haired thorax with the normal Noctuid markings. I have lately very fully discussed the genus in the pages of the Canadian Entomologist, to which paper I refer the student. *Carneades* differs by the mucronate clypeus; *Anytus* by the lashed eyes; *Agrotiphila* by the constricted eyes; our species of *Ammoconia* by the ridge on the thorax, they may not be congeneric with the European as they seem slighter, but their essential character refers them here. Finally, *Eucoptocnemis* is used for a species of Guenée's described by Mr. Morrison, which differs in the claw to fore tibiæ, and *Adita* is employed for a large species with spinose middle and hind tibiæ but unarmed fore tibiæ provided with a stout claw. *Pachnobia* is referred by Lederer to the *Orthosiinæ*.

The very numerous species of *Agrotis* described by me are here again gone over as far as practicable, and I believe I have retained none but valid species. The type of *Milleri* (named for the poet), is in the fine collection of Mr. Henry Edwards, and disputes with *Hilliana* and *Circumducta*, the claim of the handsomest species among many very pretty but some plain and even ugly (*Cochranii*) forms. I have referred to *Cupida*, all the forms which are possibly varieties, but which no one at first could be blamed for considering distinct. *Alternata* is at least a good variety; I have seen some reddish specimens approaching *Cupida*, but still with pale terminal field. *Cupidissima* is represented by specimens, tending to brownish in Mr. Neumœgen's extensive collection. *Brunneipennis* is applied to small specimens with obliterate markings, very deep red-brown varying to bright orange red. *Orbis* has the orbicular minute, and may be distinct. On the other hand, *Bicollaris*, small with a band on the collar, and *Variata*

much shaded with white are without any doubt on my mind valid species. I have united under the name *Declarata*, all the distinguishable forms allied to the Western type. I think that some of these may turn out distinct, in particular *Albipennis* with whitish secondaries in both sexes, while *Tricosa* and *Subgothica* may be varieties, this cannot, I think, be predicated of *Herilis*. The only yellow-winged *Agrotis* we have, my *Gilvipennis*, is now held to be the same as *Chardinyi* from Siberia. Among our showiest species are *Mimallonis*, *Bimarginalis*, *Conchis*, *Mirabilis*, *Grandipennis*, *Mireivenosa*, *Beata* and *Dollii*, chiefly from the West.

5. *Hadeninæ* m. This group has the eyes full, naked or hairy, the palpi well developed, the second joint pilose and long, ocelli, the body hirsute, and often tufted on the dorsal line, the ornamentation normal. *Fishia* has the tibiæ spinose, *Oncocnemis*, *Copimamestra* and *Copivaleria* have a claw on front tibiæ, otherwise the tibiæ in this group are unarmed. *Polyphænis herbacea*, described by Guenée, is unknown to me. *Mamestra* has hairy eyes; I include in it the species of *Dianthœcia* which have the ♀ ovipositor exserted. *Copimamestra* includes the European *Brassicæ*, and has a tibial claw. *Hadena* has naked eyes, otherwise agreeing with *Mamestra*. *Oligia* is used for very slight species referred by Guenée to *Celæna* in part; they are glistening and the usual tufts are obsolete. *Perigea* also wants the thoracic tufts except behind the collar, the eyes are naked, the vestiture mixed with scales, silky. The European species of *Dryobota* and *Valeria* have not been examined by me and our North American forms needs to be compared with these; the same is true of the species referred to *Apоrophyla*, and in part of *Polia*. In this genus the last three species form a distinct group; *Pallifera* seemed to me a true *Polia*; while *Illepida* is aberrant, with pectinate ♂ antennæ and approaches *Pachypolia*. I have discovered a true *Callopistria* in Florida; the species formerly referred to this genus I have removed under *Euherrichia* to a later group. *Admetoris* has hairy eyes and extruded ovipositor, and seems to me best placed near *Nephelodes*. *Tricholita* has the ♂ antennæ pectinate, the vestiture longer, the apices pointed, the size smaller. *Ochria* has the clypeus mucronate, otherwise the species are similar to the forms I arrange under *Gortyna*. *Macronoctua* approaches the Nonagrians, while as to *Lathosea* I am doubtful of its true affinities. The moth is hirsute with retracted head, and has some resemblances also to the Nonagrians. The Hadenoid moths belong principally to European genera, and should be studied with these in hand. After a very diligent study of European authorities, I find it impossible to arrive at a certainty without the types of European genera to consult. Our fauna is remarkable for the numerous species of *Oncocnemis*. Among the American genera *Hadenella* is to be noted for the clypeal horn and *Lussa* for the long untufted abdomen and narrow wing, looking like a Pyralid; the genus is from the tropical faunal province of southern Florida, and maybe West Indian also; I am not certain that it is rightly placed, it has a certain resemblance to *Perigea*. It is difficult to separate some of the species

I have placed under *Gortyna* from *Orthosia*, and perhaps when the early stages are known, and the species more minutely studied, some changes will be found necessary. The principle changes from my classification, however, will probably be made with *Polia*, *Dryobota*, etc.

The true type of *Apamea*, is, I believe, *Nictitans*. The genera *Gortyna* and *Hydræcia* have the same type, *Micacea*. I have employed the genus *Ochria*, used solely for *Flavago* in the "Verzeichniss," for our two species which have also a clypeal thorn. This character may be trivial, but it is everywhere used, and cannot be rejected arbitrarily. As with *Sphida*, it separates here species I would gladly keep united. From the pectinate antennæ (the opposite of *Nephelodes*), the thoracic tuft and the general contour I would keep *Tricholita*, with its three species, distinct from *Nephelodes*; the white reniform is characteristic, and allies the moths to *Nictitans*. I have a note to the effect that *Semiaperta* had been described previously by Walker, but cannot at the moment find the citation. With some few other changes, the fewer the better, this will be made whenever the British Museum collection is compared with our material. If the idea of justice or injustice can be held to be properly associated with matters of this kind, it may be held unjust to restore any of Dr. Walker's names where recognition is a matter of impossibility without reference to the type. This is the case with about three-fourths of his descriptions in the *Noctuidæ*. But, disagreeing with Professor Riley, Mr. Walker's description of *Xylina Antennata* and *H. Signosa* are not of these, and the moths are referred moreover to the right genus.

6. *Arzaminæ* m. This remarkable group has aquatic larvæ, with spiracles, as discovered by Prof. Comstock, and the larvæ may be taken in the leaves of pond lilies and other water-plants and swimming free in the water. They inhabit ponds from Canada to Florida, and the chrysalis may be found under stones and logs on the margin. *Obliquata* is found in Niagara river, the pupa having occurred on Strawberry island. *Vulnifica* has been found at Ithaca, and what is probably a variety, with the anal tuft blackish, in Florida lakes. *Diffusa* has been found in Maine and also collected by Mr. Moffat in Canada. The moths are very thick-bodied and heavy insects, remarkable for the large female anal tuft, like that of some forms of *Bombyx*. *Sphida* has the clypeus mucronate, *Arzama* unarmed; the difference is very slight and unessential.

7. *Nonagriinæ* m. This, to me the most interesting subfamily of the group, is equivalent to the *Nonagriadæ* of Dr. Harris. The eyes are full, naked or hairy, the thorax smoothly haired, rarely with a crest, the abdomen untufted. The wings are rather narrower and longer than usual, most often of a pale buff, or the color of dried reeds. The moths are found by the sea-coast, or in marshy places quite often, and the larvæ live on grasses. *Nonagria* has naked eyes and a large clypeal protuberance; one species from Florida is of unusually large size. I class here *Tota*, which has somewhat ovate fore wings and a triply pointed clypeal horn; it resembles *Senta* in shape of wing, but the ornamentation is hadeniform. *Tapinostola*

has one undoubted American species, but I am doubtful that I have correctly referred *Senta Deflecta*, of which I have given a figure (which in some copies of my Plate is colored). My genus *Ommatostola* has been examined by Dr. Speyer, and found to be valid as compared with the type of certain European genera not known to me in nature. The moth *O. Lintneri* (the "Dune Wainscot") occurs on the shores of Long Island. *Heliophila*, the typical genus, has hairy eyes and smooth clypeus, in *Ommatostola* the naked eyes are lashed, and the moth is larger than any of our species of *Heliophila*. Following the law of priority, I have adopted this pretty generic name instead of *Leucania*, which latter is proposed by Ochsenheimer without diagnosis while he quotes *Heliophila* of Hubner as synonymous. Our species are very pretty. *Rubripennis* is beautifully shaded with pale red; *Patricia* is a lovely little Western form with a silvery white stripe; a few are obscurely marked and difficult to separate, but all are very interesting. *Unipuncta* (the "Army Worm") is a very destructive species in the East; *Pallens* is also European. The eyes are hairy, the body smoothly haired, the fore wings rather narrow and tending to be pointed at apices.

The genus *Zosteropoda* is remarkable for the long hairs on secondaries above and the tufted legs. *Ufeus* is an aberrant flat form, by the form of the wings referable here, but resembling *Agrotis* in the spinose tibiæ. *Pteroisca*, of which I have seen but not examined the type, is a rough, rather odd-looking insect superficially resembling *Ufeus*, but which may not belong here. I do not know *Thaumatopsis longipalpus* Morr., nor *Monodes nucicolora* Guen., the latter may be the same as *Oligia Paginata* of Morrison. Under *Leucania* Guenée, without studying the structure of the eyes, has classified such a dissonant species as *Pseudolimacodes Littera*, probably misled by its color resemblance to some aberrant European *Heliophila*. A number of his species are not known to me, and the synonymy may be disturbed when these and the British Museum forms are accurately known.

3. *Scolecocampinæ*. I first in the North American Entomologist showed the relationship of *Scolecocampa*, *Eucalyptera* and *Doryodes*, uniting the two former which are certainly very little different. The body is slender, linear, the palpi long, the legs long, slender, and unarmed, the fore wings pointed. The ornamentation tends to the development of a central stripe tapering to apices. There is certainly a species of *Doryodes* figured by Geyer, which may or may not be our *acutaria*, but seems to me that species. Guenée refers the moth to the *Geometridæ*, but is corrected by Clemens, who takes occasion to sharply review Gueneé's whole work in a criticism which has become celebrated from the notice taken of it in Europe. Zeller refers *Phiprosopus* also to the *Geometridæ*, but I detected ocelli, and the neuration being also Noctuidous I referred the moth originally to the present family and as allied to *Calpe*. I think now the moth is best placed next to *Doryodes* from its similar form, but it is not without resemblances as to extra European genera which seem related to *Calpe*.

My paper, which is earlier than Zeller's, was published while I was in the South, and the generic name was mis-spelled *Phyprosopus*, how the error occurred I cannot now say; I derived the genus from *philo* and *prosopus*, shortening the first word from the undue length of the combination. I am led here to review the few cases where my names were misprinted so far as noticed by me. In all cases I made the correction as soon as possible, and in the case of the *Pluria* in the same volume.

Phiprosopus Callitrichoides *as* Phyprosopus Callitrichoides.
Phisia Viridisignata *as* Plusia Viridisigma.
Perigea Sole *as* Perigea Scole.
Hadena Perpensa *as* Hadena Perpenoa.
Oncocnemis Gracillima *as* Oncocnemis Gracillinea.
Heliochilus Paradoxus *as* Heliocheilus Paradoxus.

9. *Nolaphaninæ* m. The genus *Nolaphana* was considered a *Tortrix* by Fitch, and a Lithosian by Zeller. I detected ocelli, and was disposed to consider the moth a Noctuid, which Zeller agreed to, and figured the neuration. Three species are known to me in nature which differ somewhat in structure; *Malana* has pectinate antennæ, while *Zelleri* has them simple, and in other respects comes nearer my genus *Acliprophanes* which has a posterior thoracic tuft and longer, Caradrina-like wings, whereas in *Nolaphana* the wings are somewhat fuller and rounded, and the moth looks not unlike a *Nola*, from which ocelli, form of labial palpi and neuration separate it. However, I found vein 5 much more removed from 4 than usual, in a preparation of *Malana*, and perhaps we may not have the best location for the moth yet. *Crambodes* looks a little like the European *Axylia Putris*.

10. *Caradrinæ*. This group contains genera with smooth vestiture, untufted, often flattened abdomen and somewhat narrow palpi. The moths are closely allied to certain Hadenoid genera, and the material arranged under *Caradrina* is possibly not consonant. *Fotella* resembles in appearance the species figured by Herrich-Schæffer as *Bryophila Teratophora*. It is more robust, the fringe on hind wings longer, and the moth seems related to *Acosmetia*. Our species of *Pyrophila* are fewer than the European. The moths all have a greasy or silky look, and are fond of hiding under dead bark, where I have found *Pyrophila Pyramidoides* in numbers associated with *Agrotis Clandestina*.

11. *Tæniocampinæ* m. The forms here grouped have as a rule hairy eyes, retracted head, unarmed tibiæ, and hairy or woody vestiture. They are brown in color and usually hibernate as moths. *Orthodes* and *Himella* are silky, like the preceding *Caradrinæ*, *Tæniocampa* contains species which resemble *Agrotis* in look, and have untufted rather weak abdomen and thick vestiture; *Incerta* inhabits Europe and America; some of the forms are rather slight and difficult to separate from *Dianthœcia*, Perigrapha has a medial ridge; *Crocigrapha* a small tuft behind the collar; *Xylomiges* is something like *Lithophane* in form of thorax; *Morrisonia* has

simple antennæ with ornamentation recalling *Cloantha*; *Anchocelis* has naked eyes with the clypeus mucronate, our species is much smaller and differs slightly from the European type; *Parastichtis* (*Dyschorista* Led.), has naked eyes and exserted ♀ oviduct, with somewhat the form of *Dianthœcia*.

12. *Orthosiinæ* m. The numerous genera grouped here seem to fall in between *Tæniocampa* and *Cucullia*. The moths hibernate, as in the former group; they are colored yellow and brown like the autumn leaves in which they hide, and among them may be found some of our handsomest insects. The eyes are naked, the body as a rule untufted, tending to be flat, the ovipositor is concealed. *Metalepsis* has spinose tibiæ, sunken head, pectinate male antennæ, a hollowed out collar, in front discolorous, untufted thorax, short untufted abdomen, naked, lashed eyes. The moth has probably a European congener. *Pachnobia Carnea* has a more woolly thorax, the collar straight; it it found in richly colored varieties on Mount Washington and in Labrador; both these genera have resemblances to preceding group. The ensuing genera have also spinose tibiæ. *Trichorthosia* has hairy eyes and sharply pointed wings. *Pseudorthosia* to the appearance of Orthosia has spinose tibiæ. *Choephira* is broader-winged with stoutly pectinate antennæ, and in the body parts resembles *Zotheca*. *Pseudoglæa* has a flattened abdomen, and appears related to the European *Mesagona*. *Cea* is wide winged, slight and mealy scaled, with naked eyes and unarmed tibiæ; *Calymnia* differs by the smooth front. *Trichocosmia* with similar habit has shortly-haired eyes *Ipimorpha* (= *Plastenis*) has straight costal margin and sharp apices. The typical *Orthosiæ* much resemble *Hadena*; they are yellow and brown and the genus contains three stout species. *Cònradi*, *Lutosa* and *Citima* which would be taken for *Hadenæ* with untufted abdomen. *Cosmia* is longer winged, and our species may be the same as the European *Paleacea*. *Homoglæa* has pectinate antennæ; *Glæa* simple antennæ and untufted flattened body; *Epiglæa* has a thoracic ridge. *Jodia* resembles *Trichorthosia* in shape of wings with naked eyes; the species has sharply pointed wings, and is red in color, and prepares us for *Eucirrœdia* with uneven produced external margin, and *Scoliopteryx* with angulate wings and exaggeratedly tufted flattened body, the tufts like *Eurhipia* which the moth approaches in color and pattern, the flattened body like *Lithophane*. *Scopelosoma* has a flattened body with a small tuft behind collar and even outer margin; our species are numerous, in part variable, whether all strictly belong here is a question I am disposed to be pretty confident about, but *Pettiti* and the yellow forms incline to *Xanthia*. Our species of *Lithophane* are numerous; *Pexata* may be the same as *Ingrica* and *Thaxteri* is regarded as a geographical modification of the European *Conformis*. Till the stages are all known and compared, it is safer to keep our forms under separate names; they should not be united except under complete evidence, judging from what we know of *Occidentalis* for instance, where the larvæ are so distinct. I incline to believe *Lithomia Germana* is not different from

the European *Solidaginis;* the genus has a tuft behind collar; also our *Calocampa Impera* is closer to the European *Vetusta* than I once thought it to be; *Calocampa Cineritia* is found across the Continent, and is decidedly a different species from either of the European; the same (as to distinctness) is true of the prettier *C. Curvimacula* from the East. In this group *Carnosa* is beyond doubt the handsomest species; even the egg laid in the fall on maple leaves, is of a rich wine-red color. There is a very interesting study opened by the colors of the moths of this group which blend with the ripening leaves among which they hide. Mr. Moffat, a most painstaking observer, has beaten fresh specimens of several *Scopelosomæ* out of oak leaves, in particular *S. Græfiana, S. Moffatiana* and the deeply red *S. Ceromatica,* with its waxy chalybeous shadings, have been captured in this way beautifully fresh.

13. *Cuculliinæ* m. The wings are long and narrow, the hind wings reduced in size. The eyes are naked. The antennæ simple, except in *C. Serraticornis,* an anomalous species from the Western coast. The collar is hood-shaped; the body cylindrical, heavy, long and tufted on the dorsum of abdomen which much exceeds the secondaries. *Cucullia* is represented by but few species in comparison with the European, yet all the groups seem represented in our fauna, in which *C. Convexipennis* comes nearest to the European type of the genus. *Cleophana* is represented by two species which have a claw on fore tibiæ, the collar hood-shaped, and the general appearance more like *Cucullia* than the European species. *C. Eulepis,* is a handsomely marked species; *C. Antipoda* was erroneously described as a *Cucullia.* The genus *Nyctophæata* was described by me almost simultaneously as a Heliothid under the name of *Epinyctis.* The naked lashed eyes, the hairy vestiture, the absence of a hood-shaped collar, the sunken head, the truncate, thickly spined tibiæ are all Heliothid characters, and bring the moth near to *Grotella* and allied genera. Its describer excludes it from the Heliothians, and does not indicate its position. After seeing a very fine specimen of the beautiful moth in Mr. Neumœgen's large collection I can only place it here from the long narrow wings and stout body; but it contradicts the main features of the group so much that the form alone unites it, and my original position for the moth may finally be found the most natural. The Rev. Mr. Hulst's paper is, I find, dated two months before my own in "Canadian Entomologist" so that my *G. Notatella* has to be dropped for *N. Magdalena.* The moth is among the most beautiful and elegant of the family.

14. *Eurhipiinæ* m. This group agrees with *Cucullia* in the small hind wings. The genus *Ripogenus* is close to the European *Eurhipia,* but differs in detail in the shape of primaries and tuftings of the body. The moth is provided with two terminal abdominal tufts, one on each side, and is tufted along the dorsal line, with longer tufts on the basal segments above. The moth is of a beautiful brownish-red of various shade, with a bluish patch on median field below enclosing yellow dots. Apices shaded with bluish-white; two superposed dots in place of reniform; transverse

lines pale, irregular; the terminal narrow field and the sub-basal field of a deep rich brown. Hind wings white at base, with a black subterminal shade band followed by a terminal rich brown edge. The margin is angulated on both wings. The other genus *Marasmalus* is narrower bodied, and has the remarkable faculty of holding the wings when at rest like a fan. The two species occur from Maine to Texas; the larger and handsomer *M. Ventilator* is colored like *Ripogenus;* the other is darker and more obscurely tinted, and apparently not uncommon. I took the generic name of *Pulcherrimus* from the Indian, as its colors and ornamentation lent themselves to my fancy as being like the work made by our North American Indians; I did not know then, twenty years ago, that it had a near ally in southern Europe. The names in the other genus are suggestive of the fan-folded wings, which my friend Sanborn likened to those of *Tettix*, and the way in which the moths seem suddenly to disappear. *R. Pulcherrimus* is one of our handsomest Noctuids of this division of the family. I do not think the European fauna has anything prettier than our *Agrotis Hilliana, A. Circumdata, Oncocnemis Atriafasciata, Homoglæa Carnosa, Nyctophæta Magdalena, Ripogenus Pulcherrimus, Rhodosea Julia, Rhodophora Florida, Euleucyptera Cumatilis, Adonisea Pulchripennis, Dasypoudæa Lucens* and *Meadii*, while in the Plusias, those brilliant gems of color, our *Plusia Mappa* is hard to beat.

15. *Ingurinæ* m. The genus *Ingura* is characterized by the antennæ of the male being pectinated at base, the pectinations decreasing suddenly at tip. This form gives the genus a notodentiform look, which Mr. Walker has availed himself of to classify some of our species among the Bombyces. The abdomen is cylindrical, the wings rather narrow and the rounded secondaries are rather small. There is thus a certain resemblance to the preceding groups. Hubner figures a species, which I have not made out, in the "Zutraege," and this seems the earliest notice of any species. The colors are black and dingy, and the ornamentation offers a certain resemblance to *Abrostola*. But *Oculatrix* is an exception, the species having pinkish eye-like markings on the fore wings, and being a showy little insect. In structure it cannot be doubted the genus stands next to *Marasmalus*.

16. *Anomiinæ* m. This subfamily is characterized by the large naked eyes, the smoothly scaled body, tapering abdomen and close silky vestiture. The wings tend to be wide and perhaps *Eulepidotis* belongs here. The larva are half-loopers and approach the *Plusia* type. *Anomis* has the wings angulated, and the type *Erosa* is colored not unlike *Xanthia;* the larva has an additional pair of feet developed as compared with *Aletia*. In a study of the false or abdominal feet of caterpillars, I find that there is always some indication in the Noctuid genera which have the superior pair aborted, of the position of these feet, and that the discontinuance of use and the consequent arching of the body at this point is very gradual. *Aletia Argillacea*, the cotton worm moth, has been studied by me in the South. It has undoubtedly effected a lodging with us during the latter

part of the last century, owing to the cultivation of cotton upon which it feeds. It came every year with the zoölogical wave which follows the rising thermometer and the extension of summer over the northern part of our Continent. I discovered that the moth hibernates with us (where it occurs) as a moth, and that it gradually proceeds northward, breeding as it goes, until in the early fall months it has passed the area of cotton growing, and is found in Maine and Canada in the months of September and October. In the North it is very probable that it has found a substitute food-plant, though I do not know it, upon which the final brood is matured. But I found out that it was winter-killed over a large region, or surviving, the wintering moths failed to make a spring brood. How far North this state of affairs is complete is not yet ascertained.

To resume my remarks on the *Anomiinæ*. *Pteræthólix* has the male primary provided with a blister-like expansion, and the male of the broader-winged *Chytoryza* has a smaller one. It is here that the wings, being entire, and broadening, tend to resemble the *Ophiusinæ*, and make it likely that the large naked-eyed and smoothly-haired *Eulepidotis* belongs more naturally in this subfamily. The body structure is very similar in all the genera here discussed and its type, once apprehended, is easy of detection. The head is broader and freer than in the Drasteria-like group with which I precede *Catocala* and allies. We have at least two species of *Aletia*; the second a Texan form which may have also a more southern parentage. In form the genus *Aletia* is more typical of the group than *Anomis* with its angulated wings.

17. *Litoprosopinæ* m. This group has the terminal joint of palpi elongated, and resembles *Plusia*, differing by the more robust and untufted body. The eyes are naked; tibiæ unarmed. The wings are long and without the broadening outwardly, and the tooth at anal angle which characterizes the three next groups. *Litoprosopus* is a tropical form, and Professor Pœy describes a species, *L. Hatney*, from Cuba. Our form is found in Florida.

18, *Calpinæ* m. We have only one genus which is equivalent to the European, and in fact our single species may not be different from *Thalictri*. I do not know *Hemiceras Cadmia* of Guenée, nor whether it really belongs to the present group.

19. *Stiriinæ* m. This group is characterized by rather weak body-parts, the thorax short, having the tegulæ often deflected at the tips, the collar a little relieved, the abdomen untufted, the ovipositor prominent, the wings widening outwardly, and often with a projection at anal angle, the fore tibiæ with a claw, the palpi weak and with small third joint, conical and more prominent in *Basilodes*. As a group it oscillates between *Calpe* and *Plusia* in shape of wing and ornamentation, this being sheeny or metallic quite often, in armature of tibiæ and in appearance (*Plagiomimicus*, *Acopa*) it presents an occasional resemblance to the *Heliothinæ*. The palpi differ from the *Plusiinæ* as also the untufted abdomen and the improminent head. I have lately reviewed the genera in "Canadian Entomolo-

gist." The perfect insects are fond of flowers and one (*Cirrhophanus*) appears to be an internal feeder in stems or capsules as a larva.

20. *Plusiinæ* m. The head is more prominent, the third palpal article longer, and the body tufted on the dorsal line. These tufts are prominent in *Plusia*, and there is an exaggerated tuft, fan-shaped, on the abdomen in *Behrensia*, a genus which is nearest to *Abrostola*. *Diastema Tigris* has been sent to Mr. Hy. Edwards from Florida, and seems generically distinct from *Telerilla;* I have not been able to examine it carefully. The species of *Plusia* hover over flowers in the evening like *Sphingidæ;* a few species, *Ni, Precationis, Dydus, Verruca*, I have found active in the daytime, as are several species in the next group. Our species are both numerous and beautiful, but a little darker and richer-colored, less metallic perhaps, than the European. Most interesting are two forms, *Thyatiroides* and *Formosa*, which are mimetic of the genera *Thyatira* and *Leptina* respectively; a curious circumstance when we reflect that *Thyatira* was placed near *Plusia* by certain early authorities.

21. *Heliothinæ* m. The abdomen is conical, untufted, the vestiture hairy, the head usually retracted, the antennæ simple, ocelli present, eyes naked or hairy, often narrowed or constricted, the tibiæ armed, the anterior tibiæ shortened. The colors are bright and pretty, and the species frequent flowers; in the closing blossoms of *Œnothera Biennis*, as described by Prof. Kellicott, who has watched the species in all stages, the moth of *Rhodophora Florida* conceals itself, flower and moth being of the same colors. My arrangement of the genera commences with the nine typical forms *Heliothis* and the genus *Melicliptria*, which I have separated from *Heliothis*, and closes with the usual paler, white genera which show an approach to the following Acontians. As I have shown, I recognized, in 1874, the probable large extent of my genus *Lygranthæcia*. I kept, however, certain forms distinct upon modifications of tibial structure, leaving the responsibility of certain genera with Guenée. But any student with the microscope in hand, and my remarks before him, could have come to the conclusion now reached by Mr. Smith, with a show of originality which is wanting in fact. Mr. Smith unites my species of *Tricopis, Euleucyptera* and *Schinia* with *Lygranthæcia*, for which genus he keeps the term *Schinia*, a name which I alone had "resurrected" for the species described by Hubner, thus destroying my connection with the genus which is essentially my work. These do, in fact, present but slight modification of tibial structure, the changeable nature of which is shown by an excellent plate furnished by Mr. Smith, who, from a comparison of all accessible types, arrives at conclusions which, as a rule, I feel bound and glad to accept. But I believe he goes too far in sinking *Tricopis* and making *Euleucyptera* synonymous. I also believe that *Tertia*, which I had described under *Tamila* (under a mistaken view of the characters of that genus which Mr. Smith now corrects), will prove, with *Cupes*, generically distinct. I refer to some points in the generic descriptions given in this

paper, and now only notice the most prominent characters of certain of the genera.

Rhodosea differs from *Alaria* by the fore tibiæ having two terminal claws, else unarmed; these claws are on each side at the extremity of joint; the other two tibiæ are unarmed, although in my first notice I described these tibiæ as sparely pilose. The genus is remarkable for the apparent slight exsertion of the infra-clypeal plate at the middle, the shape of wings, palpi, give comparative characters to separate the roseate, most delicately colored moth from our Eastern genus *Rhodophora*. This last I keep distinct from *Alaria*, the palpi, colors and pattern of the moth seem to me sufficiently modified as to warrant a different term. I draw in *Porrima* (proposed for *Ovia*), a term which I employed for *Sanguinea*, a moth to which *Regia* is allied, as not distinct enough from *Lygranthœcia*, and, except as to the points here discussed, accept Mr. Smith's conclusions. As to *Cupes*, it is admittedly out of place in *Lygranthœcia*, and I keep it in *Heliothis*, to which it is at least as strongly allied, for the present. I used the narrowed eyes to separate certain genera, and this character is adopted by Mr. Smith, who finds it of great value. It led me to classify *Agrotiphila* in this group, and near *Anarta*. In this latter genus are one or two species (*Submarina*, etc.), in which the hairy eyes are not ovate but full, but which from the untufted abdomen and general aspect and ornamentation I cannot refer to *Mamestra*. *Oxycnemis* is a bright gray moth, looking a little like a species of *Charadra* or even a *Dianthœcia capsularis*, which has short front tibiæ terminating in a single claw, and a posterior thoracic tuft of shining curved scales. It is thus allied to *Triocnemis*, which has the shortened tibial joint of the fore feet also corneous, but tridentate, a posterior thoracic tuft, of which the scales are similar, while the moth recalls in ornamentation the European genus *Calophasia*. *Derrima*, placed by Walker in the *Acontidæ*. which led me to overlook this description, has one pretty species *Henrietta* m., quite common in Rhode Island, where Mrs. Bridgham has collected it. After examining Mr. Walker's type of *Stellata*, which is larger and with pink hind wings and an apparent slight modification of the markings of fore wings, I feel sure that it is only a varietal form of *Henrietta*, though this was next to impossible from the description. I have seen no such specimen among hundreds of *Henrietta* which have passed through my hands, and the only approach to it was a ♀ specimen, collected by Mrs. Bridgham, which had a faint pink flush on hind wings. The genus *Euedwardsia* is based on a fine species somewhat stouter and larger than *Xanthothrix Ranunculi*, with hairy vestiture, unarmed tibiæ, the clypeus with a projection below a cup-like excavation. The eyes are naked, the primaries are rather short and broad, with sharp apices. There will be a difference of opinion as to the value of structure in this group. I do not agree with Lederer in referring *Pyrrhia Umbra* and *Chariclea Delphinii* to one genus. But there is no need of personal criticism, and no mental inferiority or biological ignorance implied in separating certain species upon

slight structural characters. I am inclined to keep in view the general appearance and pattern of the insects in sorting them into genera, this has led me too far in the present group, as shown by Mr. Smith, and I have modified my views in consequence. There may be a question as to two or three genera which I here retain, but no harm is done by keeping them separate, and the natural grouping of the insects is facilitated. In but few cases have I overlooked the characters as charged by Mr. Smith, I have rather failed to recognize their true importance, and, without the European types before me, and wanting some rare American species, it was difficult to avoid making too many genera, considering the strong modifications in armature exhibited by the different species. After having positively referred *Oxylos* to *Heliothis*, Mr. Smith as positively now refers the genus to *Alaria*. Perhaps, when our species are all known, the genus may turn out to be valid ; it differs very slightly from *Heliothis* as stated by me, the shape of the wings divide it from *Alaria ;* thus I leave it for the present with one or two others, and having again gone over the generic types accessible to me in this group, the present arrangement expresses my final decision and comprehension of the matter.

22. *Acontiinæ* m. This group contains the large genus *Tarache* (*Acontia* Ochs.) which is numerously represented in Africa and Southern Europe. Our American forms are only partially known. The vestiture is scaly, mossy and short on the front, the eyes are full, large, naked and unlashed. The colors are white with shades of olivaceous or purply, on fine dark streaks and scintillant patches. The finest species is *Tarache Lactipennis* Harvey, which simulates *Ciris Wilsonii*. *Trichotarache* differs in the important character of hairs mixed with the body vestiture ; it borrows a character from the preceding group ; the moth closely resembles *T. Flavipennis* in appearance. *Trileuca* has the shining look of *Tarache*, and in the body parts resembles my *Buxea* from Texas, which has an European analogue, judging from descriptions. The tibiæ are unarmed ; both forms have three pale transverse lines, and are of a peculiar fady ochry color.

23. *Eustrotiinæ* m. This group is equivalent to the *Noctuo-Phalænidi* of Boisduval, and contains mostly weak-bodied and frail-winged forms of which a few are remarkably distinct in structure. *Spragueia* differs from the European *Agrophila*, by the absence of vein 5 on the secondaries, and the narrower fore wings, which have the course of the subcostal veinlets modified. *Thalpochares* has no accessory cell ; I have examined the neuration alone of *Ætheria* and *Patula*. *Euherrichia* is of a rich brown color with silver spots and lines, and has been confounded with the European genus *Eriopus*, of which latter genus we have a Floridian representative. *Annaphila* is a curious Californian genus, the species looking like miniature *Catocalæ ;* the genus appears to me related to *Eustrotia*. *Azenia* is remarkable for the clypeal structure. *Exyra* has a roughly haired thorax, and the species feed, in the larval state, on the Pitcher Plant (*Sarracenia*). The economies of nature are very curious. While many flowers, in losing their honey, have their seeds ripened by the pollen brought to the ovary

attached to the moth or bee that steals their sweets, in the genus *Saracenia* the leaves are eaten by the larva of *Exyra*, the moths of which are afterwards caught in the trap which first helped them to exist. The insect first devours the plant, and then the tables are turned, and the plant catches the moth which eat its leaves as a caterpillar. The species of *Exyra* are all pretty, while *E. Rolandiana* is one of the most beautiful of our smaller *Noctuidæ*, in fact few equal it in depth and richness of coloring. *Prothymia coccineifascia* has beautiful waxy, red stripes on its yellow wings, while for bright and elegant markings and high color few natural objects are as exquisite as *Spragueia Leo* and *S. Magnifica*. The latter species, from Arizona, is even handsomer than the species of the Tineid genus *Æta*, which these little *Noctuidæ* somewhat recall. I have worked out the structure of *Agrophila* (*Erotyla*), *Spragueia* and *Xanthoptera* very fully in the pages of the "Canadian Entomologist," edited by my kind friend, Mr. Wm. Saunders.

24. *Hyblæinæ* m. This group is tropical and is composed of singular-looking Noctuids, having tortriciform primaries, pointed apices, smoothly-haired thorax, with pointed palpi. The narrow wings and closely-haired body give the group a resemblance to the *Acontiinæ*. The hind wings are black and yellow, and in many features the group prepares us for such Catocaline forms as *Hypocala*. We have one species from Florida, *Hyblæa Puera* Fabr., which has been apparently redescribed by Mr. Strecker as a new genus and species under the odd name of "*Ænigma Mirandum*," the genus being based on a "very large number of subcostal nervules," an impossible one where it is considered that the number of these veins is invariable.

FERALIA Grote (1874).

Type: Diphthera Jocosa *Guen.*

The eyes are small, naked, lashed. The head is retracted and the palpi shorter than in *Diphthera fallax*, which latter I regard as belonging to *Diphthera* as Hubner originally intended the genus. The male antennæ are stoutly but shortly bipectinate throughout their length. I could not find ocelli, but Mr. Smith says they are small but present. The vestiture is very shaggy and hairy. The species varies by becoming suffused with black; the fore wings are green, and the female has them pale green with distinct black mesial bands and lunule beneath.

1. F. Jocosa *Guen.* Noct. 1, 47; Grote, B. B. S. N. S. II., 58 ♂, Can. Ent. XV., 28 ♀. Maine; N. York; Canada.

MOMAPHANA Grote.

Type: M. Comstocki *Grote.*

This genus is allied to *Diphthera*, the vestiture being similar, and the moth otherwise in markings and color resembling *D. Fallax*. The male antennæ are distinctly pectinate, however, and in this resembles *Feralia*, from which it differs by the less retracted head. The single species is so

rare that I never have had but one specimen to examine in which the labial palpi were much shorter than in *Diphthera Fallax*. The eyes were fuller than in *Feralia*, and the body less pilose. The ocelli were present. The moth stands evidently between the *Feralia Jocosa* and *Diphthera Fallax*, and the genus must be again studied, though I do not doubt its validity.

1 M. Comstocki *Grote*, B. B. S. N. S. II., 59 (*Feralia*), Stett. Ent. Zeit. New York.

ADITA Grote (1874).

Type: A. Chionanthi *Abbott and Smith*.

The moth is allied to *Agrotis*, from which it differs by the fore tibiæ being provided with a stout claw as in *Oncocnemis*. Middle and hind tibiæ sparsely spinose, while the front tibiæ seem to have only the terminal claw, and to be destitute of spinules. Abdomen untufted. Male antennæ bipectinate, rather long. Head prominent, eyes full, naked. Fore wings retreating at anal angle. The thorax is crested behind. The moth is figured by Abbott in 1797, and remained undiscovered, and even unnoticed again until 1874, when I found it in a collection made by Prof. Comstock at Ithaca, New York. It is a large, distinctly marked and handsome species, expanding about 42 mil., and has since been found in Massachusetts, but is as yet rare in collections.

1. A. Chionanthi *Abb. & Sm.*, II., Pl. 98; Grote, B. B. S. N. S. II., 63. Mass. to Georgia.

HILLIA Grote.

Type: Hadena Senescens *Grote*.

This genus is allied to *Hadena* with which it essentially agrees, but differs by the retracted head and short body, and the straight costal margin of the primaries, the wings being wide and short, rather than comparatively long and narrow. Male antennæ simple, ciliate; eyes naked, lashed. A tuft behind the collar and on thorax behind. Tibiæ unarmed. Abdomen untufted.

1. H. Senescens *Grote*, Can. Ent. 10, 235, New York.
2. H. Vigilans *Grote*, B. U. S. G. S. 4, 176, Maine.
3. H. Algens *Grote*, Can. Ent. 10, 236, Maine.

I name this genus for W W. Hall, Esq., of Albany, who collected the type, and has been exceedingly kind to me in scientific matters.

COPIVALERIA Grote.

Type: Valeria Grotei *Morr*.

This form has a roughly haired thorax, the head being somewhat sunken, the male antennæ impectinate. The form is like *Hadena*, but it differs by the claw on front tibiæ. The aspect is not unlike the European genus *Valeria*, and it is removed from *Dicopis* by the longer wings and abdomen.

1. C. Grotei *Morrison*. Eastern and Middle States.

HADENELLA Grote (1883).

This genus is based on a Hadenoid of slight build, having triangulate, broad wings, the infra-clypeal plate prominent, a curious projecting frontal horn terminating in a navel shaped expansion. The thorax is tufted behind, the antennæ simple, the eyes naked; a small basal tuft on the abdomen. The little moth is gray, shaded over apices and the middle of the wing with ochreous, thus resembling in miniature *Agrotis Pluralis*. It is of the same slight form, but brighter colored than the dusty gray *Hadena cylindrica*.

1. H. Pergentilis *Grote*. Arizona.

PSEUDANARTA Hy. Edw. in litt.

Type P. crocea *Hy. Edw.*

This genus is composed of small Hadenoid forms which have clear yellow secondaries with black borders, and resemble *Anarta myrtilli* in appearance. The eyes are naked, the head not as prominent as in typical Hadenoid species. The antennæ are simple, the vestiture hairy, the thorax tufted. It is a color genus apparently as the tibiæ are unarmed, and beyond the peculiar color, and somewhat compressed form I do not find distinctional characters, although I cannot help believing that such exist. The species are near, but I now believe are all distinct. All but *flava* have yellow, this has orange secondaries. The fore wings of *crocea* are shaded with ochrey and paler than the others. It is probable that the ♀ oviduct is exserted, which would give a slight character.

1. P. Crocea *Hy. Edw.* Colorado.
2. P. Flava *Grote*, Col.; B. Columbia.

TOTA Grote (1882).

Type T. Armata *Grote*.

Size small, form compact, fore wings somewhat tortriciform, shaped like the European *Senta*, with hadeniform ornamentation gray, with faint markings finely outlined. Tibiæ slender, unarmed, fore tibiæ with a short claw. Clypeus with an exceedingly prominent wedge shaped protuberance, surmounting the greatly exserted infra-clypeal plate. Hind wings rather full, rounded, the fringe prominent. Two species, one larger with pale fuscous or smoky secondaries, the second smaller with glistening white hind wings, resemble each other closely in appearance. On examination the central point of the clypeal wedge has a shallow depression on top in the second smaller form (*minorata*), in which the head and collar are distinctly ochrey. The larger form (*armata*) has a variety having a submedian and discal black streak; this recalls the *var. Bipuncta* of the European species of *Senta*, although it is the stigmata which are filled with black. The untufted body, the clypeal armature resemble *Nonagria*; the small species have the look of internal feeders.

1. T. Armata *Grote*, Can. Ent. 175. Arizona.
2. T. Minorata Grote, Can. Ent. 181. Arizona.

UFEUS Grote (1873).

Type: U. Satyricus *Grote.*

A very flat-bodied, coarsely-haired genus with shiny feet and simple antennæ, the middle and hind tibiæ spinose, as also the fore tibiæ in at least two of the species. The body is untufted, and in form the moths resemble *Heliophila*, and are classified by me at the end of the subfamily group. *Nonagriinæ* m. The naked eyes are lashed. The type is found in Canada, and the Northern States. I suspect it hibernates as a moth. The early stages are unknown.

1. U. Satyricus *Grote*, B. B. S. N. S. I, 101, Pl. 3, fig. 4. Can. to N. Y.
2. U. Unicolor *Grote*, B. U. S. G. S. IV., 179. Illinois.
3. U. Plicatus *Grote*, B. B. S. N. S. I., 102. Can. to California.
4. U. Sagittarius *Grote*, Pap. III., 31. California.

The ornamentation is simple; *Satyricus*, a large species, fuscous, with cloudy medial lines, *unicolor* smoky-fuscous, unlined.

Plicatus is brownish-red with medial lines and varies in tint; it is smaller than *Sagittarius*, which has red primaries with a yellow longitudinal streak on cell joining the bow-shaped yellow reniform, while beneath the secondaries have a thick triangulate mark. This species is the most interestingly marked in the genus. The flat form, coarse hair, strongly spinose and powerful feet are unmoth-like, and when I examined *Satyricus* I was reminded of a cockroach, though I confess it requires a strong imagination to even suggest such a resemblance.

FOTELLA Grote (1882).

Type: F. Notalis *Grote.*

This genus is related to *Caradrina*, and has a slight correspondence to *Acosmetia* in form, the fringes are long on hind wings. Clypeus with a navel-shaped expansion. Eyes unlashed, naked. Ocelli. Wings full; the color and markings recall *Bryophila Teratophora.* Tibiæ unarmed; body slender, untufted; vestiture silky.

1. F. Notalis *Grote*, Can. Ent. 14, 181. Arizona.

ACERRA Grote.

Type: A. Normalis *Grote.*

This genus is, I believe, synonymous with *Perigrapha* Led. It has the characters of *Tæniocampa*, except that the body seems stouter and shorter, and there is a medial ridge on the thorax. Our species seem to differ by the impectinate ♂ antennæ. The European species have large confluent stigmata, and our first two species have them thus, and very prominently colored, the next two have them also coalesced, but not so prominent, and in the last two the stigmata are separate and inconspicuous. The genus seems to sustain a similar relation to *Tæniocampa*, that *Ammoconia* does to *Agrotis* or *Epiglæa* to *Glæa.*

1. P. Normalis *Grote*, B. B. S. N. S. II., 162; Check List, fig. 4. California.
2. P. Muricina *Grote*, B. B. S. N, S. III., 85. Oregon.

3. P. Behrensiana *Grote*, Can. Ent. VII., 71. California.
4. P. Plusiiformis *Hy. Edw.*, Pac. Coast Lep. 4, 3, Pl. 1, fig. 9. Nevada.
5. P. Erythrolita *Grote*, Can. Ent. XI., 208. California.
6. P. Transparens *Grote*, B. U. S. G. S. VI., 582. Washington Terr.

The genus *Stretchia* of Hy. Edwards, with the type *S. Plusiiformis*, is also synonymous. The handsomest and most striking species is *Muricina;* while *Erythrolita* has much the look of a *Tæniocampa*, its larger ally. *Transparens* has a certain false look of *Phragmatobia*, from its subtransparent rufous primaries with their faint ornamentation. The hairy eyes and the dorsal ridge of scales on the thorax must be observed.

CEA Grote (1883).

Allied in form, texture and vestiture to *Trichocosmia*, between this and *Calymnia*. Eyes naked, unlashed. Vestiture of narrow scales. Antennæ simple. Front wide, rising to an embossed protuberance, around which the short clypeal vestiture circles; infra-clypeal plate distinct. Ocelli. Labial palpi slender, rather weak, with elongate third joint. The body has a pale integument, the outline weak, and the vestiture is not strongly adherent. Tibiæ unarmed; legs rather short and weak, not hairy. Body untufted; abdomen with dorsal carina. Wings entire, rather broad and short; apices determinate and outwardly the primaries are full. One species with thorax and primaries very pale yellow, almost white, immaculate. Hind wings pure silky white above and below, abdomen white, expands 27 mil.

1. C. Immacula *Grote*, p. III., 78. Arizona.

CIRRHOPHANUS Gr. (1872).

Type: C. Triangulifer *Gr.*

The eyes are full, naked, unlashed. The clypeus has a central rounded tubercle. The vestiture consists of hair-like scales with broader ones, arranged like shingles, rising from the thorax, which is short and in shape allies the moth to this group. The fore tibiæ are also not truncate, but as long as in the preceding genera and unarmed. The parts of the thorax resemble the preceding genera, but there is a divided posterior tuft. The patagia are not as deflected as in *Plagiomimicus*, but do not lie close to the thorax. The female ovipositor is not exserted. The abdomen is untufted. The labial palpi have the terminal joint concealed, and are not unlike, though longer, the palpi of the genera separated here from *Basilodes*, but unlike that genus. The antennæ have the basal joint scaled. The palpi are rather thickly haired. The tibiæ are unarmed. Wings ample, without tooth, rounded exteriorly, with blunt apices, and running in a little and forming a prominent angle at internal margin. The genus seems to be somewhat intermediate between the preceding and *Plusia*. The species is golden-yellow with orange-brown lines disposed somewhat like the European *Chariclea Delphinii*.

1. Triangulifer *Gr.* Ohio, Missouri.
Pretiosa Morr. (Chariclea).

CHAMAECLEA Gr. (1883).

Type: C. Pernana *Gr.*

Allied to the genera typical of the *Stiriinæ* by the bulging clypeus and Plusia-shaped wings. Front with a slight depression, rising in the middle. Vestiture scaly. Tibiæ unarmed; in all the examples I have seen the fore legs are broken off. Fore wings wide, produced at internal angle. The tegulæ are not deflected; the thorax short. ♂ antennæ simple.

1. Pernana *Gr.* Arizona. This genus is curious for the way in which *Chamæclea Pernana* mimics *Chariclea Delphinii.* The type is figured in my Illustrated Essay on the Noctuidæ of North America, Plate III. fig. 27.

PLAGIOMIMICUS Gr. (1873).

Type: P. Pityochromus Gr.

Front with an empty and exposed cup-shaped protuberance, the frontal scales being short and mossy. A slender terminal claw on front tibiæ. In *Tepperi* the frontal excavation is less prominent, but otherwise this species agrees. As compared with allied genera, the three species are slenderer and have a casual resemblance to the Heliothid genera *Schinia* and *Lygranthœcia.* As in *Stibadium* the labial palpi are short, here they hardly reach the top of the more prominent infra-clypeal plate in the more typical forms. The species are olivaceous fuscous (*Pityochromus, Expallidus*), or of a delicate olivaceous green (*Tepperi*). Both Mr. Morrison and Mr. Smith wrongly give the fore tibiæ of *Tepperi* as unarmed.

1. Pityochromus *Gr.* Mass to Kansas and the South.
   Schinia media Morr.
2. Expallidus *Gr.* Montana.
3. Tepperi *Morr.* Southern States, Arizona.

HELIOSEA Grote (1875).

Type: H. Pictipennis *Grote.*

A small Heliothid allied to *Heliophana* and *Melicleptria.* It differs by the fore wings being more widened outwardly, and the claw to the front tibiæ being single. Mr. Smith says of it: "Very unsatisfactorily distinguished from *Heliophana* and probably identical with it." I cannot re-examine my type at the moment. When I established the genus, I was under the impression that the modifications of the armature of fore tibiæ gave generic characters. With the discovery of numerous Heliothid forms this opinion has become modified.

1. Heliosea Pictipennis *Grote*, Ill. Essay, p. Plate 3, fig. . California.

MELICLEPTRIA Hubn. (1816).

Type: M. Cardui *Hubn.*

This genus, which I took from Hubner, is equivalent to Lederer's first section of *Heliothis* as shown by me, and, with the same type, the equivalent of Guenée's genus *Anthœcia.* I followed Guenée in including in it

such forms as *Saguarina*, etc., but in my "New Check List" limited it more rigorously to the purple and black forms. *Celeris*, a magnificent species, is, as I twice showed from examination of specimens, a true *Melicleptria*, it was misplaced accidentally in my list. Mr. Smith has farther taken out a few species described under it by Mr. Hy. Edwards and Mr. Morrison, which with similar ornamentation are shown to differ structurally. I cannot now examine all these while he is apparently justified in his course. I cannot believe he has correctly placed *Perminuta*, but I only saw the type, and have never had the species under the microscope. He follows Mr. Edwards in regarding my genus *Adonisea* as synonymous. I suspected as much myself, but the species was too handsome to leave undistinguished, and it has a slightly different proportion from the rest. This insect, which I call "Adonis' Moth," is purply red and blue, the latter shade a very unusual one in the ornamentation of these insects. I described the genus with other Californian genera, but my present knowledge of related forms would have deterred me from doing so. The species of *Melicleptria* have naked, small or ornate eyes, which are sunken in the hairy vestiture of the retracted head. The middle and hind tibiæ are spinose. The fore tibiæ in *Pulchripennis* have a longer inner and two outer claws, and as in most of the genera the joint is short. Mr. Smith says "the body is clothed with thin divergent hair, usually of a paler color than body [?] and somewhat silky." He thus describes the sericeous somewhat olivaceous or yellowish longer vestiture on thorax and abdomen which is distinctive and with the purply red wings, with paler median spots on both pair, is characteristic of most of the species. Mr. Smith further gives the "claws of tarsi simple or but slightly dentate." In the female the ovipositor is extended beyond the conical and rather short untufted abdomen. A typical species is *M. Sueta*, with its Californian variety *Californiensis*.

1. M. Celeris *Grote*, B. B. S. N. S. I., 148. California.
2. M. Pulchripennis *Grote*, Ill. Essay, 62, Pl. III. fig. 31, *var.* Languida *Hy. Edw.* California.
3. M. Villosa *Grote*, P. E. S. P., 531, Pl. VI., fig. 6. Colorado.
4. M. Persimilis *Grote*, B. B. S. N. S. I., 117, Pl. III. 11. Colorado.
5. M. Græfiana *Tepper*, Tr. Am. E. S. 245. California.
6. M. Honesta *Grote*, Papilio I., 77. California.
7. M. Sueta *Grote*, B. B. S. N. S. I., 117. Colorado.
   var Californiensis *Grote*. California.

LYGRANTHŒCIA G. and R.

Type : Anth. Rivulosa *Guen.*

The type of this genus was first described as *Crambus Marginatus* by Haworth. It is a sufficient answer to Mr. Smith's prejudiced procedure of calling this genus *Schinia*, and giving himself the air of first discovering it, to quote my words from my paper in the Buffalo Bulletin II., 220, which is the only one I had published on the subfamily *Heliothinæ*. "The

eyes are full. The fore wings of the usual shape, crossed by two or more less evident lines. The fore tibiæ have a series of three outer claws or spinose, a single inner longer terminal claw, succeeded by a row of slender spines. The species are numerous, and I refer them all to *Lygranthœcia* G. and R. They are *bina, lynx, brevis, atrites, arcifera, Spraguei, Packardi, Mortua, jaguarina Marginata, Thoureani, saturata.*" It will thus be seen that I referred all the then known species to this genus. I only left out my *Tricopis* and *Euleucyptera*, which to-day I am not willing to add, as also Hubner's *Schinia* then not known to me, or but partly. I afterwards in my "New Check List," proposed to divide the species into two genera, but incorrectly. I also described some new species (incorrectly, as Mr. Smith has shown) under *Tamila*. But the first attempt to limit this large genus scientifically is that above given, and to now call that genus *Schinia*, a term "resurrected" by myself out of Hubner for two or three of his species, is quite unjust and against the usual comity and practice, and I hope will not be followed by any one. The species I now arrange as follows: I have adopted Mr. Smith's conclusions except as above noted, but the genus is virtually my genus *Lygranthœcia*, and its value is not altered by referring to it a few species hitherto wrongly placed by me. I had not the type of *Tamila*, and was misled by Guenée's diagnosis, and my own prepossession that the flattened thoracic scales distinguished *Tamila*, while in reality all the species have them. The genus is well distinguished by the full, not ovate or narrowed eyes from its allies, and thus stands near the typical *Heliothis armiger*.

RHODODIPSA Grote (1879).

Type: R. Volupia *Fitch*.

This genus is nearest to *Lygranthœcia*, and differs in detail of armature from *Rhodophora* and *Alaria*. The second species from New Mexico may not belong here, the front tibiæ of the type were imperfect. Both have light crimson secondaries and honey-yellow thorax. The fore wings of *Volupia* are also red with fine pulverulent pale lines, while those of *Miniana* are clay-color with broader white lines, recalling those of *L. Velaris*. Mr. Smith unites the first species with *Alaria*, and having been so fortunate as to see Dr. Fitch's type, confirms my identification in my Illustrated Essay, p. 63, and elsewhere; alone from the description certainty as to the species intended by Dr. Fitch could not be attained.

1. R. Volupia *Fitch;* Gr. B. U. S. G. S. III., 797; Ill, Ess. 63, Pl. 3, 33. Texas; Colorado.
2. R. Miniana *Grote*, Papilio I., 175; II, Pl. I., fig. 1–2. New Mexico.

PORRIMA Grote (1875).

Type: Oria Sanguinea *Geyer*.

This is a catalogue name proposed by me instead of Guenée's generic term *Oria*, preoccupied by Hubner. I found afterwards that the near-

est ally of this moth was the *Heliothis Regia* of Mr. Strecker, a moth which I had previously referred to *Lygranthœcia* (= *Schinia* Smith) before Mr. Smith wrote on the subject. In his "Synopsis," Mr. Smith says: "Congeneric with this (*Alaria*) are *Porrima* Gr., and *Rhodophora* Guen. The former seems to differ in being rather more coarsely haired, more wooly (woolly) beneath, having the primaries a little wider, and the fringes longer. The latter has the vestiture a little finer, and the palpi slightly drooping instead of horizontal; there is also a very slight difference in the armature of the anterior tibiæ; *but compared carefully with each other the conclusion that they are identical is irresistible*; not only do they agree in outine and general characteristics but even the coloration, slight as it is, would seem to bring them together" (l. c. p. 19). The italics are mine. In his next paper Mr. Smith refers *Sanguinea* to *Schinia!* I believe Mr. Smith is right in his last conclusion, and I have referred *Sanguinea*, next to *Regia*, to *Lygranthœcia*. If this opinion should be reversed by later discoveries *Porrima* may come into use for the genus as intended by Guenée. I have quoted Mr. Smith to show how easy it is to be positive and change one's opinion quite quickly. A very long continued study and a knowledge of the greater part of our *Noctuidæ* has shown me that it is better to be not so positive as matters are at present. I differ decidedly from Mr. Smith's opinion that *Sanguinea* is like *Florida*. The genus *Porrima* must for the present be regarded as not sufficiently distinct from *Lygranthœcia*. I do not in the least object to a change in opinion upon such matters, but I object to being adversely criticised for changing my opinions by one who changes his own. The process in itself is a very natural one, without which all progress would be impossible. A scientific man is one who changes his views with facility upon the discovery of fresh evidence, and one also who is quick to see the bearing of fresh evidence upon the subject in hand.

OXYCNEMIS Grote (1882).

Type: O. Advena *Grote.*

A Heliothid genus with shortened fore tibiæ which are corneous and terminate in a single claw. Vestiture scaly. Thorax with posterior tuft of curved scintillant scales, widening towards their tips. Eyes naked, unlashed. Abdomen short, untufted. The moth is gray, brightly marked, with distinct hadeniform ornamentation, of small size and from its essential features I place the moth next to *Triocnemis*. The type is in Mr. Neumoegen's extensive collection.

1. O. Advena *Grote*, Can. Ent. 14, 182. Arizona.

AZENIA Grote (1882).

Type: A. Implora *Grote.*

Size small, allied to *Prothymia*. The vestiture is flattened hairy. Eyes naked, unlashed. Antennæ simple. Legs unarmed and tibiæ thinly scaled. Front with infra-clypeal plate prominent, overshadowed by a parallel,

long, distinctly tridentate, flattened clypeal protuberance. Labial palpi oblique, rather stout and longer than in *Xanthoptera*. The type is pale lemon yellow with dots in place of median lines and pale fringes. The second species is dark yellow without marks and uncolorous fringes ; the frontal armature has its outer edge roundly scalloped instead of forming the three sharp teeth of *A. Implora*.

1. A. Implora *Grote*, Papilio II., 186. Arizona.
2. A. Edentata *Grote*, Can. Ent. XV., 25. Arizona.

EUHERRICHIA Grote (1882).

Type : Eriopus Monetifera *Guen.*

Form slender ; abdomen not exceeding the secondaries, tufted at base, and especially on third segment. Eyes naked, unlashed. Ocelli. Tibiæ unarmed. Vestiture consisting of flattened scales mixed with hair. Wings broad, entire, apices determinate, outer margin retiring below apex, full at median nervules ; a distinct accessory cell ; 9 out of 8 to apices, about half the length of 8 ; cell open ; 3 twice further from 4 than 4 from 5 at base. Hind wings with vein 5 a little weaker, indistinctly connected with median series, The species are rich reddish-brown ornamented with silver spots and lines recalling *Plusia* and having somewhat the soft rich color of *Plusia Mappa*. The species have been mistaken for forms of *Eriopis*.

1. E. Monetifera *Guen.* Can, to Florida,
2. E. Mollissima *Guen.* Can. to Florida.
3. E. Floridensis *Guen* Florida.

I conclude this paper by briefly referring to the fact that I have determined my species in many collections. I enumerate those of Mr. Thaxter, Mr. Neumoegen, Mr. Hy. Edwards, Mr. Tepper and in the Albany collections. A large number of my types are in Mr. Neumoegen's grand collection, and I have figured a good number of the species. There can thus be but few cases of doubt as to what I have described. I had intended, in memory of many kindnesses, to dedicate a second illustrated work to Mr. Roland Thaxter, but circumstances prevent me, and if he will accept the present paper on his favorite subject, I shall be glad. I know of no one who by natural temper and talent is better fitted to continue the description of North American *Noctuidæ* than Mr. Thaxter, could he be induced to undertake the work,

A Revision of the Lysiopetalidæ, a family of Chilognath Myriopoda, with a notice of the genus Cambala. By A. S. Packard, Jr.

(Read before the American Philosophical Society, June 16, 1883.)

In the course of some studies on the cave-fauna of the United States, it became necessary in treating of the cave-inhabiting myriopods to work carefully over their structure, and as they all, with a single exception, belong to the *Lysiopetalidæ*, a revision of a group which has been hitherto much neglected, may prove of service to zoölogists.

My material mainly consists of specimens collected by myself for the Kentucky Geological Survey; also, some collected by Mr. F. G. Sanborn for the same survey. I have also been indebted to Mr. E. Burgess, Prof. C. V. Riley and U. S. Department of Agriculture, for a few specimens.

Until 1840, when Brandt described the genus Lysiopetalum (and its synonym Spirostrephon), no genus of the family, as it is now understood, existed. In his Recueil, p. 42, he referred some southern European species to his new genus Lysiopetalum, mentioning *Julus fœtidissimus* Savi as the type. On p. 90 of the same work he proposed the genus *Spirostrephon* for our more common American species, the *Julus lactarius* described by Thomas Say in 1821.

In 1845, in his classical memoir in the Philosophical Transactions of London, on the Myriopoda, Mr. G. Newport proposed the sub-family (with Platops and Cambala as generic types) *Lysiopetalinæ*, with the following brief diagnosis: *Pedes laminis mobilibus affixi.*

In 1865, in his Myriopoda of North America, published in the Transactions of this Society, Dr. H. C. Wood, Jr., recognized the family rank of the group for which he proposed the name, *Lysiopetalidæ*, with the following diagnosis: "Sterna atrophied, not coalescent with or united by suture to the scuta." The type and only genus mentioned is *Spirostrephon* (*S. lactarius*).

Mr. Ryder's paper in the Proceedings of the U. S. National Museum, 1880, was the first attempt to enumerate the species, and his detection and account of the genus Zygonopus added materially to our knowledge of the group.

The synonomy of the family will be as follows:

Family Lysiopetalidæ Wood.

Lysiopetalinæ Newport, Phil. Trans., xix, 278, 1845.
Lysiopetalidæ Wood, Trans. Amer. Phil. Soc., xiii, 137, 1865.
Koch, Verh. Zool.-bot. Ges. in Wien, xvii, 1867 (Zool. Record, p. 194, 1868).
Ryder, Proc. U. S. Nat. Museum, iii, 524, 1881.
Packard, Amer. Nat., xvii, 328, March, 1883.

Synopsis of the Genera.

A. Body not setose ; antennæ long ; male legs of eighth pair not modified; genital armature of normal proportions......*Lysiopetalum* Brandt.
Male legs of eighth pair modified, six jointed ; genital armature small *Pseudotremia* Cope.

B. Body setose.
Body short and thick, eyes triangular ; antennæ slender ; setæ one-fifth as long as body is thick ; legs short..... *Cryptotrichus* Packard.
Body short and fusiform, eighth pair of legs of male two-jointed ; setæ half as long as body is thick .... *Trichopetalum* Harger.
Body slender ; eighth pair of male legs two-jointed, ending in a claw ; setæ very long ; eyeless............................ *Scoterpes* Cope.
Like Scoterpes ; setæ a little shorter ; sixth pair of male legs greatly swollen .... *Zygonopus* Ryder.

Characters of the Family. The diagnostic characters of the group, as distinguished from the Julidæ, are as follows : Head broad, wider than the body in front ; genæ much swollen, front flat ; eyes situated in a triangle, often partly or wholly aborted ; antennæ seven-jointed, much longer and more setose than in the Julidæ, especially the third and fifth joints, and also the seventh (terminal) joint. Body subfusiform, constricted behind the head, the first and second segments being much narrower than in the Julidæ. The segments usually divided into an anterior raised portion, often with longitudinal ridges, and a posterior plain depressed smaller portion ; on the sides of the anterior portion of the segments of the anterior half or two-thirds of the body a swollen boss or hump, with three setiferous tubercles ; the setæ from one-third to two-thirds as long as the body is thick. Feet very long and slender, as long as the body is thick, or sometimes longer. The coxæ contiguous, the sterna very rudimentary, not united with the scuta. In the males the sixth pair of feet enlarged and swollen (in Zygonopus) ; the eighth pair two-jointed and rudimentary ; number of body-segments variable ; end of body pointed.

To enter into more detail, the following comparative description of the family characters may be useful :

The Head. The head of the Lysiopetalidæ is more like that of the Polydesmidæ than the Julidæ ; the genæ are remarkably swollen, and as in the Polydesmidæ separated by suture from the rest of the epicranium ; they are higher and narrower oval than in the Polydesmidæ. The front of the head is much flattened, forming a squarish pseudo-clypeal region separated by a faint suture from the epicranium ; the sides of the head or genal region are swollen, forming a slight median depression on the vertex. The labrum is much as in the Julidæ, with three median nearly equal teeth, and with four setæ on each side as in the Julidæ. Finally, in the form and anatomy of the head, the Lysiopetalidæ approach the Polydesmidæ more closely than the Julidæ ; the nearest approach to the family in

the Polydesmidæ is seen in the head of *Polydesmus ocellatus* Pack. and *P. cavicola* Pack., both American forms.

The Eyes. When well developed the eyes are equilaterally triangular, *i. e.*, the ocelli are arranged in a triangular area; in *Lysiopetalum lactarium* there are 40–41 facets arranged in rows. In *Cryptotrichus cæsioannulatus*, where the eye is also developed, there are about 24 facets; as several of the species inhabit caves, and suffer a partial or total loss of eyes, there is much variation in the number of ocelli; in *Pseudotremia cavernarum* the eyes are irregularly linear; the ocelli being arranged in about four irregular groups, with 11–19 ocelli, the number of ocelli varying in different individuals of the same species. In Trichopetalum the ocelli vary from 10–19. In *Scoterpes* and *Zygonopus* the eyes are entirely wanting. In those eyes which are partially aborted, there are a few partly developed ocelli, less than half as wide as, and scattered irregularly among, the normal ones.

The Antennæ. These are much longer and slenderer than in any Julidæ, and more nearly resemble those of the Polydesmidæ than the former family; but differ from both groups in the much longer terminal joint, and in the decided inequality in the relative length of the joints, the third and fourth joint being much longer than the others; the number of joints in our American species being invariably seven (not counting the basal undeveloped eminence to which the first joint is attached). The antennæ are longest and slenderest in Pseudotremia and Lysiopetalum, and shortest in Scoterpes, Zygonopus and Trichopetalum. The joints are more setose in Trichopetalum, and least so, perhaps, in Scoterpes. In all the genera there are from two to four flattened, enlarged, broad, fusiform tactile hairs situated on the end of the terminal joint. As observed in Lysiopetalum and Pseudotremia, these hairs are two-jointed, the basal joint short and broad; they are filled with granules like the material filling the spaces in the nervous fibres between the nerve-cells in the terminal antennal joint, which is nearly filled with nerve fibres and very small nerve-cells, showing that the antennæ must be very sensitive tactile organs, especially in the blind forms.

The Arthromeres. The body-segments of the Lysiopetalidæ have a definite family form and style of ornamentation. In Lysiopetalum and Pseudotremia all the scutes are ornamented with numerous longitudinal ridges, which end in a point overhanging the depressed, flattened portion of the scute; in Pseudotremia, which is a modification by cave-life of the first named genus, the ridges are more or less obsolete and replaced by flattened, coarse granulations, and the lateral swellings of the scutes are well developed.

In all the other genera, the scutes are not thus ridged, and the lateral bosses or swellings are distinct; in all except Cryptotrichus, the bosses have three setiferous, acute tubercles arranged in an irregular triangle; in Cryptotrichus the tubercles are farther apart, arranged almost in a straight

line, but one situated on the boss, which is smaller than usual; the uppermost tubercle is very near the median line of the body. The setæ are straight and stiff, pointing upward and either forward or backward, and are longest in Scoterpes, and shortest in Cryptotrichus where they are minute and about one-fourth as long as the body is thick. Below and behind the lateral boss, the surface is sometimes chased with nearly parallel oblique lines, or, as in Cryptotrichus, the depressed hinder edge of the scutes is finely striated longitudinally. The end of the body is usually much more acutely pointed than in the Julidæ.

Having received, through the kindness of Dr. Latzel, specimens of *Lysiopetalum carinatum* Brandt, from Dalmatia, which is a very large species, I have been able to examine the repugnatorial pores, which are very distinct, their crateriform openings being situated each between two ridges on the anterior edge of the raised portion of the scute. In *L. illyricum* Latzel, from Austria, they are with difficulty perceived, the area in which they are situated not being discolored with yellow; but they can be detected with a half-inch objective. The two European species mentioned are provided with setæ, while our *L. lactarium* is naked. In the latter species the repugnatorial pores are situated in the middle of the yellow lateral spot, between two carinæ, which are higher and closer together than any of the others. They can be seen with a Tolles triplet.

Examining the cave Lysiopetalid, *Pseudotremia cavernarum* Cope, from Wyandotte cave, and a variety, *carterensis*, which inhabits the Carter caves, Ky., I cannot with certainty discover their site, as they are nearly, if not quite, obsolete. It is possible that in cave species, where there are apparently no enemies of these myriopods, their pores become at least externally obsolete.

The Legs. The number of joints of the legs in general is six; the second and third, especially the third, being the longest (this inequality in the length of the joints is an important family character); the fourth and fifth joints are very short, about equal in length, while the sixth and last joint is long and slender, ending in a slender claw.

Of the three pairs of primary or larval legs, the first pair are variously modified in different genera. In *Lysiopetalum lactarius* the first legs are rather flat and short; the third joint from the claw nearly thrice as long as the second, while the terminal joint is broad, with a series of close-set, stiff setæ of nearly equal length, but increasing gradually in length distally; the joint is evidently a comb-like structure adapted for cleaning the body, perhaps the mouth-parts. The first pair of legs in Pseudotremia are much longer and slenderer than in Lysiopetalum, six-jointed; and the terminal joint is less comb-like, both edges being densely setose, the inner edge, however, having the stoutest, most regular setæ.

The sixth pair of legs in *Zygonopus* are modified for clasping purposes, the fourth and fifth joints being much swollen, as described in the descrip-

tion of the genus; in all the other genera, as in all Diplopod myriopods, so far as we are aware, the sixth pair of legs are like the others.

In each genus of Lysiopetalidæ, except Lysiopetalum itself, the eighth pair of legs, *i. e.*, the pair situated on the sixth segment or that bearing the male genital armature, is much modified. In *Lysiopetalum lactarium* the seventh and eighth pair of feet, *i. e.*, those before and behind the male genital armature, are as well developed as the other legs; it is probable that owing to the large and long genital armature, reaching beyond the basal joints of the legs, that the latter needs no change in form to assist in clasping the female. In Pseudotremia, however, the eighth pair of legs are much modified, though still six-jointed; the two basal joints are much swollen, of very irregular shape, the coxæ being consolidated; the rest of the leg is much smaller, slender, four-jointed, the third joint of the leg or basal joint of the free portion being as long as the three terminal joints less the long claw. In the three lower genera, Trichopetalum, Scoterpes and Zygonopus, the eighth pair of legs are on the same type; the two latter genera being evidently derived from the out-of-door form, Trichopetalum. In these three genera the eighth pair of legs are much aborted, two-jointed; the outer joint about thrice as long as the basal, and either unarmed or ending in a claw.

*The Male Genital Armature.** This apparatus has only been incidentally studied. In *Lysiopetalum lactarium* and Pseudotremia the *lamina externa* and *lamina interna* are much as in other Chilognaths. In the first-named genus the armature is about as large as in the Julidæ; in the Pseudotremia it is minute. In Pseudotremia and in Scoterpes and Zygonopus there is developed either upon (Pseudotremia) or at the base of the outer lamina a minute spinous appendage which we have not noticed in the figures of Vosges, Wood or Humbert. In each genus observed by us the armature presents characteristic features, so that they appear to have generic but no family characters. In Scoterpes, Trichopetalum and Zygonopus the armature is minute and rudimentary. In Scoterpes its outer lamina is tridentate at the enlarged end, while the inner lamina is sac-like and simple.

LYSIOPETALUM Brandt.

Julus Say, Journ. Acad. Nat. Sc., Phil., ii, part i, 104, 1821.
Lysiopetalum Brandt, Recueil, 42, 1840.
Spirostrephon Brandt, Bull. Sci. Acad., 1841. St. Pet., 1840. Recuil, p. 90, 1840.
Platops Newport, Ann. & Mag. Nat. Hist. xiii, 266, 1844.
Lysiopetalum Gervais (in part), Aptères, iv, 133, 1847.

* The genital armature of Julidæ have been described and figured by E. Voges in Zeitschrift für wissenschaftliche Zoologie, xxxi, 150. 1878. He regards the seventh segment as the "Copulationsring" of the male, and says, "at the bottom of the deep sac-like membranous connection of the sixth and seventh body-rings lies the Copulations-Organ" of the female.

Cambala Gervais, Aptères, iv, 134, 1847. Exped. à l'Amer. du Sud (Castelneau), Myriop., 17.
Reasia Sager, Proc. Acad. Nat. Sc., Phil., 109, 1856.
Spirostrephon Wood, Myriop. N. Amer., Trans. Amer. Phil. Soc., 192, 1865.
Cope, Proc. Amer. Phil. Soc., 179, 1769.
Ryder, Proc. U. S. Nat. Mus., iii, 526, 1881.
Not *Cambala* Gray, Griffiths, Cuvier, An. King. Ins., pl. 135, fig. 2, 1832.
" *Reasia* Gray.
" *Reasia* Jones, Todd's Cyc. Anat. Art. Myriop, 546.

Body-segments numbering as many as upwards of 60, with as many as 115 pairs of legs; the body unusually long and slender, tapering gradually towards the subacute tip. Head with the front flat, high and narrow, more so than usual; the eyes in a rectangular triangle, composed of as many as 40–41 facets, and not depressed. Antennæ rather long, the joints subclavate, joint 6 not much longer than 4; joints 3 and 5 of the same length; joint 6 rather thick at the end; joint 7 short, thick and conical, much more so than usual.

Body-segments swollen and full, becoming suddenly depressed on the front edge; the swollen portion with numerous raised lines or ridges, with deep concave valleys between; the ridges projecting behind in an acute point. The segment next to the head rather narrower than the head, with the posterior two-thirds ridged; the sides of the segments are somewhat swollen high up on the sides, but not so conspicuously as in Pseudotremia. Legs rather stout, and larger than in Pseudotremia; the first pair rather short and broad, with a regular comb of stiff setæ on the inner edge of the terminal joint. The seventh and ninth pairs of legs, *i. e.*, the pair immediately preceding and following the genital armor, are like the others, not being in any way modified as in Pseudotremia, etc. The genital armature is large and better developed than in any other genus of the family; the outer lamina large, stout, spatulate-mucronate at the tip; inner lamina much shorter than the outer, and with two long acute forks; repugnatorial pores difficult to find.

The genus may be recognized by the long, slender body, tapering to a point, and by the very short conical seventh antennal joint; by the ribbed swollen segments, which are very numerous; by the seventh and ninth pairs of legs being normal, like the others, and by the short, broad first pair, with the regular comb of setæ on the terminal joint.

The genus as here defined will apply to the two Southern European species *Lysiopetalum carinatum* Brandt and *L. illyricum* Latzel, except that they are setose, while our species is not. I am indebted to Dr. Latzel for specimens for comparison.

In proposing the genus Spirostrephon, Brandt (Bull. Sc. Acad. St. Pet., 1840), regarded Say's *Julus lactarius* as the type species, and adding that the eyes are in a triangular area, he indicates its generic difference from *Cambala annulatus*, with which it has been so often confounded.

Although I had originally retained Brandt's name Spirostrephon for our

species, yet upon receiving from Dr. Latzel authentic types of European Lysiopetalum, it is plain that our *S. lactarius* is congeneric with them. The name Spirostrephon should, then, be considered as a synonym of Lysiopetalum. It is difficult to see why Brandt should have separated *lactarius* from his *L. carinatum*.

In his Recueil, p. 42, Brandt thus characterizes his genus Lysiopetalum: *Laminæ pediferæ omnes liberæ, mobiles, cutis ope cum parte abdominali corporis cingulorum conjunctæ. Frons ante antennas dilatata et deplanata in maribus in simul depressa.* The two species mentioned under the generic diagnosis are *Lysiopetalum fœtidissimum* (Savi) and *L. carinatum* Brandt.

Again, on p. 90, "Subgenus seu genus II. *Spirostrephon* Nob." is thus characterized, and he apparently regards it as a subgenus of Julus : Gnathochilarii pars media fossa haud instructa, sede jus loco aream tetragonam planam, plica seu linea derata duplici, superiore breviore et inferiore longiore, supra et infra terminatam, sed sutura longitudinali haud divisam offerens. Spec. 27. Julus (Spirostrephon) lactarius Nob.......Differt habitu a Julis genuinis et Julo (Lysiopetalo) fœtidissimo et plicato affinis apparet. Annuli corporis, quorum posteriores brevissimi, incluso anali 53. Pedum paria 95. Longitudo 10–11‴; latitudo summa ¾‴. Oculi triangulares—Julum lactarium protypo generis Cambala Grayi habuissem, quum figura ab hocce zoologo sub nomine Cambalæ lactarii data (Griffith Anim. Kingd. Insect., pl. 135, fig. 2). The generic characters are not very applicable in distinguishing the genus, the mention of the type alone rendering it possible to understand what the genus is.

The synonymy will be farther discussed under Cambala. In 1844, Newport, having been misled by the specimen of *Cambala annulata* alleged to have been sent by Say as the type of his *Julus lactarius*, places the latter in his genus Platops, which he proposes, with a doubt, thus: "Genus *Platops? mihi.*" The generic characters apply well to the present species, *S. lactarius.*

Dr. Wood, in his Myriopoda of North America, does not attempt, for want of material, to define the genus. Prof. Cope characterizes this and the next genus thus :

Annuli without pores.................................... *Spirostrephon.*
Annuli with two pores on each side the median line....... *Pseudotremia.*

As we have seen, there are pores in Lysiopetalum, while the "two pores" of Pseudotremia are two of the three setiferous tubercles on the side of each segment.

The genus appears thus far to be represented in North America by but a single species, which ranges from Massachusetts west to Iowa and south to Florida and Louisiana, while in southeastern Europe Lysiopetalum is rich in species.

Lysiopetalum lactarium Say.

Julus lactarius Say, Journ. Acad. Nat. Sc. Phil., ii, part i, 104, 1821.
Spirostrephon lactarius Brandt, Bull. Sc. St. Pet., 1840; Recueil, 90, 1840.

Platops lineata Newport, Ann. Mag. Nat. Hist., xiii, 267, April 1844.
Lysiopetalum lineatum Gervais, Aptères, iv, 133, 1847.
Cambala lactarius Gervais (in part), Aptères, iv, 134, 1847.
Reasia spinosa Sager, Proc. Acad. Nat. Sc. Phil., 109, 1856.
Cambala lactaria Gervais, Exped. l'Amer. du Sud (Castelneau), Myriop. 17.
"*Reana chinosa* Saeger," Gervais, Exped. l'Amer. du Sud. (Castelneau) Myriop. 14.
Spirostrephon lactarius Wood, Myriop. N. Amer., Trans. Amer Phil. Soc., Phil., pl. ii, figs. 11, 11*a*, 192, 1865.
Cope, Proc. Amer. Phil. Soc., Phil., xi, No. 82, 179. 1869. Trans. Amer. Ent. Soc., iii, 66, May, 1870.
Ryder, Proc. U. S. Nat. Mus., iii, 526, Feb. 16, 1881.
Lysiopetalum lactarium Packard, Amer. Nat., xvii, 555, May, 1883.
Not *Cambala lactaria* Gray, Griff., Cuvier An. King. Ins., pl. 135, fig. 2, 1832.
Newport, Ann. Mag. Nat. Hist., xiii, 266, April, 1844.

Two ♂, two ♀. Body-segments exclusive of the head, 61, with 115 pairs of legs. Body and head horn-color, usually mottled and banded with dark blackish horn-color. The head usually with a broad, interantennal, black, conspicuous band enclosing and connecting the eyes. Eyes (compound) of 40–41 facets. Antennæ dull, blackish brown; tip of the terminal joint pale, as also the other joints at their articulation. The body with a median dull yellowish dorsal stripe, and with a lateral row of concolorous diffuse spots, one on each longest lateral ridge (the spots vary much, sometimes covering four or five ridges and extending low down on the sides of the scute. Each scute has, except those near the head and at the end of the body, about twenty-five prominent ridges, the dorsal twelve larger than those on the sides; these ridges are high, with concave valleys between them; the end of the ridges are acutely conical and project over the ends of the scutes.

Length of the entire body 35^{mm}; thickness 2^{mm}.

The above description was drawn up from the Louisiana specimens which were highly colored, banded and spotted. In the Massachusetts specimen the color is uniformly light brown, without the yellowish dorsal line and the lateral spots. The antennæ are much darker, while the legs are paler than the body. The head is much paler than the body; it is dusky on the vertex between the eyes; but there is no definite interantennal band as in the Louisiana examples.

The Iowa specimens resemble in coloration those from Louisiana, but the yellowish dorsal band and lateral spots are not quite so distinct, though the interantennal blackish band is distinct.

Massachussetts and McGregor, Iowa. Mus. Agricultural Department,

Washington, D. C. (Prof. C. V. Riley); Pilatka, Fla., and Milliken's Bend, La. (E. Burgess); "Eastern United States" (Wood); Found under bark in the mountain regions of Tennessee and North Carolina (Cope); St. Louis (Theo. Pergande).

Although this species is evidently the parent form of the cave-inhabit ing *Pseudotremia cavernarum*, it has not yet been observed near the Indiana and Kentucky caves, though undoubtedly yet to be found in their vicinity, as it is a wide-spread species. It probably ranges through Central into South America, as Dr. Wood remarks: "I have seen a single specimen, a female, labeled as coming from New Grenada, which apparently belongs to this species." This specimen I have seen in the Museum of the Philadelphia Academy of Natural Sciences, but did not compare it closely with our species; it is much larger than individuals from the United States.

PSEUDOTREMIA Cope.

Pseudotremia Cope, Proc. Amer. Phil. Soc., xi. No. 82, 179, 1869. Trans. Amer. Ent. Soc., iii, 67, May, 1870.

Spirostrephon Cope, Amer. Naturalist, vi, 414, July, 1872.

Pseudotremia Harger, Amer. Journ. Sc. & Arts, iv, August, 1872.

Ryder, Proc. U. S. Nat. Mus., iii, 524, Feb. 16, 1881.

Body consisting of thirty segments; rather long and slender, with as many as fifty pairs of legs. Head with the muscular area (gena) behind the eye very full and swollen, globose, swelling out far beyond the side of the succeeding scutum; front a little longer than wide. Eyes present, black, the outline of the eye-patch narrow triangular, composed of about twelve to fifteen facets, arranged in four or five transverse oblique series. Antennæ longer and slenderer than in any of the other genera of the family; joint 3 is twice as long but not as thick as joint 2, but equals 5 in length, the latter, however, being very slender and clavate; the terminal seventh joint is unusually long, pear-shaped and elongated towards the tip.

The body constricts in a neck-like fashion behind the head; segments (scuta) 5–20 especially have a lateral shoulder or raised portion characteristic of the genus Lysiopetalum; this swollen portion has on each side about six longitudinal ridges, with deep valleys between; above, especially on the posterior half of the body, the dorsal portion of the laterally swollen scuta is coarsely tuberculated, instead of ridged, and the rounded tubercles are rather flat and unequal in size. There are no setæ or lateral setiferous tubercles. The end of the body is as usual in the family, the last segment with three pairs of small setæ arranged one above the other.

Above the middle of the side of the posterior scuta, especially the last six, is a tubercle like those in Scoterpes and Zygonopus, but much smaller, from which a minute hair arises, and above on the upper part of the shoulder there are two rudimentary, very small tubercles.

The legs are long and slender, about one-third longer than the diameter of the body. In the male the eighth pair of legs are much less

than in the succeeding genera; it consists of five joints, while in Trichopetalum, Scoterpes and Zygonopus it is very rudimentary, consisting of but two joints. The basal joint is large and constricted near the middle, with a large setiferous tubercle on the inside; the constriction may represent an obsolete articulation, and thus the basal joint really represent the two basal joints of the other legs. The smaller multiarticulate extremity of the leg is composed of four well marked joints, the basal as long as the three terminal ones without the claw, which is long and slender, and nearly as well developed as in the other legs.

The male genital armature is well developed, nearly as much so as in the *Julidæ*. There is a median very long curved forked chitinous rod, a pair of median boot-shaped pieces, and a pair of lateral double blades or pseudorhabdites, composed of the usual *lamina externa* and *lamina interna*, which are variously spined and denticulated at their extremities, one supplementary spine being minutely and densely spinulated.

The genus was characterized by Cope thus: "Annuli with two pores on each side the median line;" as already remarked, the so-called pores appear to be simply the lateral tubercles giving rise posteriorly to minute setæ, which are difficult to detect with a half-inch objective.

The genus differs from Lysiopetalum in the slenderer, longer antennæ, the rudimentary eyes, the more swollen and prominent lateral bosses or shoulders of the segments, while the body has about half as many segments as in Lypsiopetalum, and is much shorter and more fusiform. The generic characters are very marked, though the species is clearly enough derived from the common out-of-door *Lysiopetalum lactarium*.

PSEUDOTREMIA CAVERNARUM Cope.

Pseudotremia cavernarum Cope, Proc. Amer. Phil. Soc., xi, No. 82, 179, 1869.
Trans. Amer. Ent. Soc., iii, 67, May, 1870.
Packard, Amer. Naturalist, v, 749, Dec., 1871.

Spirostrephon cavernarum Cope, Amer. Naturalist, vi, 414, July, 1872.

Spirostrephon (*Pseudotremia*) *cavernarum* Harger, Amer. Journ. Sc. and Arts, iv, 118, 119, Aug., 1872.

Pseudotremia cavernarum Ryder, Proc. U. S. Nat. Mus., iii, 526. Feb. 16, 1881.

Eyes black, conspicuous, forming a somewhat irregular, narrow triangular patch, with from twelve to fifteen facets. Antennæ unusually long and slender, the joints pilose; joints 3 and 5 of the same length, or 3 a little longer; joints 2 and 6 of equal length; joint 7 elongate, pear-shaped, pilose, the extremity truncated, with two or three sense-setæ not so long as the end of the joint is thick.

The first scutum next to the head is scutellate in shape, rounded on the front edge, somewhat produced anteriorly in the middle; the margin behind slightly sinuous; it is about two-thirds as long as broad. The second scutum is a little wider than the first; the third somewhat wider,

while the fourth is much wider; dorsal face of first scutum smooth; the posterior part of the second scutum a little swollen; that of the third more so; that of fourth scutum swollen and ridged much as in fifth and succeeding scuta. Scuta 5–20 are swollen high up on the sides into a shoulder, giving a quadrilateral instead of a circular outline to the segment, bulging out more subdorsally than below; the swelling has six longitudinal ridges, while the posterior swollen end of the scuta above, especially on the posterior half of the body, is coarsely tuberculated, the tubercles being rounded rather than flat, and unequal in size. No well-marked setiferous tubercles on the side from the middle of the body to the head; but on the last six segments there are on each shoulder or scutal swelling two minute rudimentary swellings or tubercles; but in my specimens I can see no setæ except on the two terminal segments of the body in ♂ and ♀, where on the end of the last scuta there is a seta arising from a basal movable joint; there are three pairs on the lateral anal plates (30th segment). Length 18^{mm}; thickness of the body 1.5^{mm}.

The young when about half-grown are white, the back of the antennæ and anterior segments having a very slight dusky tinge. In numerous mature specimens from the Senate Chamber, Wyandotte cave, three miles in, the body is white, with a slight flesh-colored tint. In numerous (150) specimens from this locality, the head and dorsal side of the anterior segments are slightly dusky; the antennæ are also usually slightly dusky, except the two terminal joints, which are white.

There is thus seen to be a slight amount of variation in color in specimens collected at the same date in the same chamber in Wyandotte cave.

Among the 150 specimens taken at one time and place from Wyandotte cave (Senate Chamber) and individually examined, I could see none without black eyes, the pigment being well developed. There was a fair proportion of males.

Four specimens which I collected in Little Wyandotte cave were exactly the same size as those from Great Wyandotte cave; they were white tinged, dusky on the head and fore part of the body. The eyes are black and the eye-patch of the same size and shape, while the antennæ are the same.

Six specimens from Bradford cave, Ind. (which is a small grotto formed by a vertical fissure in the rock, and only 300 to 400 yards deep), showed more variation than those from the two Wyandotte caves. They are of the same size and form, but slightly longer and a little slenderer, especially joints 3 and 5; joint 7 is decidedly longer than in any others; whiter, more bleached. The antennæ are much whiter than in those from the Wyandotte caves, and the head and body are paler, more bleached out than most of the Wyandotte specimens. The eyes vary more than in the Wyandotte examples, one having but 12 facets, another 14, and another 15, with a few minute rudimentary facets between the others. It thus appears that the body is most bleached and the eyes the most rudimentary in the Bradford cave, the smallest and most accessible,

and in which consequently there is the most variation in surroundings, temperature, access of light and changed condition of the air. Under such circumstances as these we should naturally expect the most variation.

Var. *carterensis*. A decided approach to *S. lactarius* is seen in certain brown specimens, only partly bleached, found in the Carter caves, Kentucky, viz. : Bat cave, X cave, and Zwingler's cave, besides a cave across the road from the hotel, which is used as an ice-house.

In the specimens from Bat cave, the antennæ are slightly shorter, and a little slenderer, particularly joints 3–5 ; but joint 7 is much shorter and blunter than in the Bradford cave individuals ; the antennæ, however, are of the same length, though slenderer than those living in Great Wyandotte cave. The eyes form a nearly equilaterally triangular area, with from 23 to 25 facets. The segments behind the head are thirty. They differ from the Wyandotte examples in the posterior or swollen portion being rather more prominent than in the former, forming more marked lateral swellings, with about eight ridges on the side of each boss, and the body is larger and thicker, but the legs are of the same length.

The head is dark in front, mottled above and below with paler horn-color. The antennæ are concolorous with the head and body, but the terminal joints are paler, as are the legs, which are also paler at the articulations. The entire body is dark horn-brown, mottled and irregularly lineated.

The smoother anterior portion of the scuta shows a tendency to be paler than the tuberculated portion, and of a bluish-gray tint. The tubercles are no more prominent than in the Wyandotte individuals.

The segments in both the Wyandotte species and var. *carterensis* rapidly decrease in size, the penultimate segment being pointed, and each segment is provided with regular, high-raised parallel prominent ridges on the shoulder or lateral boss, about 40–45 on a scutum on the sixth segment from the end of the body.

Length 23^{mm} ; thickness 2.5^{mm}, the body being considerably larger and thicker than in the Wyandotte specimens.

Two specimens from X cave are exactly in size and color like those from Bat cave.

Three specimens from the ice-house cave only differ from those in Bat cave in being somewhat paler, but the eyes and antennæ are the same.

A large and a partly grown one from Zwingler's cave was collected by Mr. Sanborn, Aug. 23 ; these were also paler than those from Bat cave. With them were associated a Ceuthophilus with eyes well developed, and Polydesmus.

This form or variety would be, perhaps, mistaken for *Lysiopetalum lactarium*, but it is true in all the generic details to *Pseudotremia ;* at the same time it is what may be called a "twilight" species, living in small caves in situations partially lighted. It is probably derived from *L. lactarium*, or a closely allied species ; we doubt if it will ever be found living in the same situations as *L. lactarium*.

Prof. Cope's types were first found by him in Erhart's cave. Montgomery county, and Spencer Run and Big Stony Creek caves, in Giles county, Pennsylvania; also, in Lost Creek cave, on the Holston river, in Granger county; and in other limestone caves of the valley of the Tennessee. Prof. Cope afterwards (Amer. Nat. vi, 14) discovered this species in Wyandotte cave, remarking, "The species is quite distinct from that of the Mammoth cave, and is the one I described some years ago from caves in Virginia and Tennessee."

CRYPTOTRICHUS,* nov. gen.

Pseudotremia Cope (in part), Proc. Amer. Phil. Soc., xi, No. 82, 180, 1869.

The head seen from in front is wider than long, as usual in the family, but the genæ (or sides above the base of the jaws) are not so much swollen as usual, being much as in *Zygonopus;* the front is broad and not very long, and is distinctly marked by a ridge from the vertex. The eyes are large, well-developed, prominent, and equilaterally triangular. The antennæ are large and slender, much more so than in *Trichopetalum* or *Scoterpes*, but not so long and slender as in *Pseudotremia.* The joints have somewhat the same proportionate length as in the latter genus, but while the second joint in Pseudotremia is about half as long as the third; in *Cryptotrichus* it is much longer, being about two-thirds as long as joint 3; joints 2 and 4 are of the same length, while in Pseudotremia joint 4 is considerably longer than joint 2; joint 5 is a little shorter than joint 3; joint 6 is very short and thick compared with that of Pseudotremia, being about one-third longer than thick, while in Pseudotremia the same joint is over twice as long as thick and regularly clavate; the terminal (seventh) joint is oval, moderately short and thick, about twice as long as thick; regularly oval, with two or three sensory flattened hairs of the usual form.

The body consists of thirty segments, including the lateral anal plates; it is thick and rather short, having the general proportions of Trichopetalum. The setæ being of microscopic size, the segments (scuta) appear to the naked eye to be naked and smooth; each scutum (tergite) is divided into two portions, an anterior plain and a posterior spotted portion, but there are no ridges, and but a single slightly prominent tubercle projecting backwards and situated a little below the middle of the side of the tergite; each of these tubercles, at least on the posterior half of the body, directly sends off a fine seta which is directed backwards. From each of the pale, equidistant spots, extending in a nearly straight line around the posterior edge of each scutum arises a minute hair; the same spots in front give rise to minute conical tubercles.

The legs are long and slender; as long as the body is thick.

No males have been obtained, so that the secondary sexual characters cannot be here given.

* Κρύπτω, I conceal; θρίξ, τριχός, hair; referring to the minute setæ, difficult to detect.

In describing *S. cæsioannulatus*, forming the type of the genus, Dr. Wood, in his "Myriopoda of North America," p. 194, remarks: "This species ought, perhaps, to be the type of a new genus; but, as I am unable to make out the generic characters in this family, it seems preferable to retain it in this for the present."

The genus may be recognized by its slender antennæ, its smooth scuta, and three transverse rows of setiferous pale dots; in these respects differing from Lysiopetalum and Pseudotremia.

CRYPTOTRICHUS CÆSIOANNULATUS (Wood).

Spirostrephon cæsioannulatus Wood, Myr. N. Amer., 194, Pl. ii, Fig. 14, 1865.

Pseudotremia vudii Cope, Proc. Amer. Phil. Soc., xi, No. 82, 180, 1869.

Two ♀. Eyes equilaterally triangular, convex, prominent, black. Body horn-brown in color, stained and spotted with darker brown. Head and antennæ concolorous, being dark purplish-brown; antennæ pale at the articulations of the joints. Feet slightly paler than the antennæ, whitish at the articulations. Segments (scuta) dark brown on the posterior edge, with three pale rounded distinct spots on each side, and a fourth spot below, or eight in all; from the centre of these three upper spots, on each side, arise short microscopic setæ. A median pale dorsal impressed line along the whole body, which dilates on the anterior part of each segment into a short, broad diamond-shaped area. The extreme hinder edge is smooth and pale, giving a transversely-banded appearance to the body. In one of the two specimens the lower white dots are, towards the head, more or less confluent, forming an irregular lunate spot. Length 15^{mm}.

Two ♀ specimens were kindly collected for me by Mr. C. L. Herrick, either at Culmana, Ala., or at Ocean Springs, Miss., the bottle containing Myriopods from both those localities. Dr. Wood's specimens were from Allegheny county, Penna.; and Prof. Cope's examples were from Pennsylvania.

This is a rather characteristic form, owing to the transverse series of light dots, and the linear pale transverse line on the hinder edge of each segment, so that the specific name is well chosen. What Dr. Wood is disposed to regard as "pores," appear to be slight tubercles, bearing setæ on the posterior half of the body. I have been thus far unable, with a half-inch objective to detect any repugnatorial pores in this genus or any except Lysiopetalum, but am not disposed to deny their existence. The hairs are minute and mostly rubbed off in alcoholic specimens which have been transported far. My specimens agree so well with Prof. Cope's description that I do not doubt but that his *Pseudotremia vudii* is this species. There seem to be no difference of importance. The dorsal impressed line in my specimens is a faint crease, being neither a "keel" or "groove." Cope remarks that it has twenty-nine segments; his specimen was eleven lines in length.

This Myriopod is a rather characteristic form, and appears to range from Pennsylvania to the Gulf States.

TRICHOPETALUM Harger.

Trichopetalum Harger, Amer. Jour. Sc. Arts, iv, 118, 119, Aug., 1872.

Body rather short and thick, fusiform compared with the succeeding genera, being thicker in the middle and tapering more towards each extremity than in Scoterpes and Zygonopus. Head of the general shape of that of Zygonopus, the proportions of the front and vertex being about the same; but the gena is much fuller, more globose, and the genal area is shorter and rounder. The eyes are present, black, the facets 10–19 in number, arranged in two curvilinear series, the eye-patch being lunate in shape. The antennæ are short and thick, much more so than in Scoterpes, pilose, with a few rather coarser setæ than usual: joint 2 is but slightly more than half as long as joint 3, and rather shorter than joint 4; joint 3 is considerably longer than joint 5, the latter being thick, subpyriform and swollen toward the end; joint 6 is much swollen and rounded, and about as thick as long; the seventh or terminal joint is shorter than in any other genus of the family, being rather shorter than in Scoterpes; and with two flattened sensory terminal setæ. Number of body segments, 28–31; number of pairs of legs in the female, 46. The legs are much shorter than in Zygonopus. The scutæ are posteriorly a little swollen on the sides, much less so than in the two following cave-genera; the bosses being not much over half as large; from the upper part of the boss or shoulder arise three warts or tubercles arranged as usual in a scalene triangle, and giving rise to short, rather stiff setæ, which are half as long as the segment is thick.

In the male the three pairs of legs in front of the genital armature are slightly longer than those behind or in front, but the seventh pair or that directly in front of the rudimentary eighth pair are not swollen, nor do they in any way resemble the swollen pair in Zygonopus. The eighth or rudimentary pair are two-jointed, the outer joint without a claw, only sending off a few small setæ.

The genital armature is somewhat similar to that of Zygonopus, but better developed. I could detect no lateral pores.

Mr. Harger gave the following diagnosis of the genus: "Sterna not closely united with scuta; third and fifth joints of antennæ elongated; scuta furnished with bristles; no lateral pores; eyes present." He does not attempt to give any generic characters drawn from the genitals, and in his description of *T. lunatum*, says: "The under side of the seventh segment of the male (Fig. 3) is furnished anteriorly with a pair of appendages directed backwards and curved upward," and then describes the rudimentary eighth pair of legs. Our description of the genus has been drawn up from Mr. Harger's types belonging to the Museum of Yale College, kindly loaned us for study. On such examination as we could make without dissection, the genital armature is evidently more perfectly devel-

oped than in Zygonopus and Scoterpes, but a number of specimens are needed for dissection before the structure can be clearly made out. The number of segments is 28 in *T. lunatum*; 30 in *T. iuluoides* and 31 in *T. glomeratum*. The genus appears to be distributed from the Atlantic to the eastern slope of the Cascade mountains in Oregon, as well as on the Pacific coast of Oregon.

The following are the known species of the genus which have been described by Mr. Harger:

Trichopetalum lunatum Harger, Amer. Jour. Sc. and Arts, iv. 118, Aug., 1872.* I have found in April several specimens hybernating under leaves at Providence, R. I.

Trichopetalum glomeratum Harg., l. c., 118, 1872. Valley of the John Day river, Oregon.

Trichopetalum iuluoides Harg., l. c., 118, 1872. Simmon's harbor, North shore of Lake Superior.

Genus Scoterpes Cope.

Spirostrephon (Pseudotremia) Pack., Amer. Naturalist, v. 748, Dec., 1871.
Scoterpes Cope, Amer. Naturalist, vi. p. 409, 414, July, 1872.

Body very long and slender, not fusiform, consisting of thirty segments besides the head, and with about fifty two pairs of legs, with the penultimate joint very long. Head rather large, and unusually broad; no eyes present; the genæ unusually large, extending high up on the vertex, but not so globose as in Trichopetalum, the front is also carried farther up on the vertex than usual, and is much broader than long; the clypeus flat, slightly bilobed on the front edge. The antennæ are moderately long and hairy, with the sixth segment scarcely longer than in Trichopetalum, but more uniform in thickness, scarcely longer than thick, the terminal joint as long as the sixth, the end conical, more produced than in Trichopetalum or Zygonopus; at the tip are four rather long sense setæ. Body segments becoming as usual smaller next to the head; the anterior of each division of the arthromere much swollen high up on the sides; each shoulder with three tubercles, which are arranged in a scalene triangle and bearing much longer setæ than in the other genera, though not quite so long as the body is thick. The legs are long and slender, much more so than in Trichopetalum, and somewhat more so than in Zygonopus. In the male the eighth pair of legs are rudimentary, being two-jointed, the second joint only one fourth longer than the basal, and ending in a well developed stout claw. The genital armature minute and very rudimentary, pale, scarcely chitinous, the outer lamina short and thick, with a stout external recurved spine, and two terminal obtuse points; the inner lamina shorter, forming a truncated angular spine, and not much more than half as long as the outer lamina, between the inner and outer laminæ, its base next to the inner lamina is a middle spine ending in an irregular tuft of fine spinules.

* Author's extras, published July 13, 1872, New Haven, Conn.

The genus is distinguished from Trichopetalum by its want of eyes, its broader head, its long slender body, with long setæ, by the eighth pair of female rudimentary legs ending in a claw. From Zygonopus it differs in the shorter sixth antennal joint; its broader head; its slenderer legs, the sixth pair in the female not being unlike the others, and by the more prominent shoulders and longer setæ. The species of the two genera are of the same general form and size.

The genus Scoterpes was proposed by Prof. Cope for the present species in the American Naturalist for July, 1872, p. 414. The characters given are the "lack of eyes and of lateral pores;" the absence of the latter having been "asserted by Dr. Packard." Ignorant of the difference between the Mammoth cave blind Myriopod and Lysiopetalum, the latter being the only genus of the family then known, we referred it to that genus (Spirostrephon).

SCOTERPES COPEI Cope.

Spirostrephon (*Pseudotremia*) *copei* Packard, Amer. Nat., v, 748, Dec., 1871.
Scoterpes copei Cope, Amer. Nat., vi, 414, July, 1872.
Spirostrephon copei Harger, Amer. Journ, Sc., iv, Aug., 1872.
Packard, Zoölogy, Edit. 1-3, 1879–81.

About 29 ♂ and ♀ examined. Body white, with no dusky discolorations; 30 segments besides the head in specimens 11^{mm} in length and 52 pairs of legs; in one female individual 8^{mm} long there were 49 pairs of legs, including the eighth or rudimentary pair; in other individuals 6^{mm} long there are 24 segments behind the head. The head is provided with short, fine erect hairs of different lengths, especially on the sides of the genæ. In the absence of a second species, we cannot distinguish all the specific from the generic characters; for minor specific characters the reader is referred to figures to be hereafter published by the Geological Survey of Kentucky.

The males and females are alike in size and form.

The specimens were most abundant in the Labyrinth in Mammoth cave, but also occurred in other localities in the cave. It is also common in Diamond cave, where I collected it, and was discovered by Mr. Sanborn in Poynter's cave, 300 yards from daylight. In one of the specimens from the last-mentioned cave, the antennæ were rather more slender than usual.

The genus *Scoterpes*, and its single species *copei*, appears to be limited to Mammoth cave and the others near, in apparently the same system of caves. It was erroneously reported by me to occur in Weyer's and the Luray caves, as the specimens collected belong to *Zygonopus whitei*. Without doubt the genus is a modified Trichopetalum, which has become longer and slenderer in body, with longer legs and antennæ as well as setæ; whether it is a descendant of *Trichopetalum lunatum* or not is uncertain; it may have descended from a different species; but there seems

to be no reasonable doubt but that it is a modified form of a small hairy Lysiopetaloid form, with antennæ exactly like those of Trichopetalum.

ZYGONOPUS Ryder.

Zygonopus Ryder, Proc. U. S. Nat. Mus., iii, 527, Feb. 16, 1881.

Body rather slenderer than in Scoterpes. The head differs from Scoterpes in being much narrower and higher, the swollen sides or genæ being much less swollen; the vertex is swollen; the front as broad as long with the upper edge a little hollowed, but quite distinct from the vertex itself The eyes entirely wanting, as in Scoterpes. The antennæ are rather thick, and in this respect approach Scoterpes, but the sixth and seventh joints are much longer, and rather more setose; the sixth joint is about two-thirds as thick as long, and the last (seventh) joint nearly twice as long as thick. The sides of the segments are swollen subdorsally as in Scoterpes, and the setiferous tubercles are arranged as in that genus, but the setæ are shorter; the lower posterior edges of the arthromeres below the shoulder or hump is chased obliquely with fine impressed lines. The feet are less in number than in Scoterpes. The diagnostic characters of the genus lie in the remarkably swollen sixth pair of feet of the male, in which the second joint is rather thick, while the third joint is long, and with the fourth joint remarkably swollen, with a series of about nine oblique retractor muscles diverging from the proximal end of the terminal joint, which is long and slender and straight, with a well-developed claw The seventh pair of the male are of the normal form The rudimentary or eighth pair are like those of Trichopetalum, the second (terminal) joint not ending in a claw, thus differing from those of Scoterpes. The male genital armature is entirely unlike that of Scoterpes, though it is rudimentary and minute; the outer lamina consists of a basal subtriangular portion, ending in a long slender curved spine, beneath which is a stouter spine, shorter and less curved; a minute median setose lamina is present, while the inner lamina is a weak, slender setose filamentary outgrowth.

Mr. Ryder's generic characters are stated very briefly, as follows: "Sixth pair of legs very robust, and with the third joint greatly swollen." The generic characters are not contrasted with those of Scoterpes.

This genus differs from Scoterpes in the remarkably swollen, clasping sixth pair of legs, and in the male genital armature, while either sex differs from Scoterpes in the much narrower head, and longer sixth and seventh antennal joints.

ZYGONOPUS WHITEI Ryder.

Spirostrephon copei Pack., Amer. Nat., xv, 231, March, 1881.
Zygonopus whitei Ryder, Proc. U. S. Nat. Mus., iii, p. 527, Feb. 16, 1881.

Eight ♂, 10 ♀. Body white, long and slender, number of segments 33. Head with scattered, fine setæ; antennæ with the second joint not quite one-half as long as the third, which about equals the fifth in length, both

being rather long; the sixth is thick, barrel-shaped, not quite one-half as long as the fifth, but scarcely thicker; the seventh joint is unusually long, a little more than three-fourths as long as the sixth joint; the end thick and well rounded, with the usual tactile large flattened setæ; the 3–7th joints with long dense setæ, a few in the end of joint 5 longer than any on joints 6 and 7. The setæ on the body arise from tubercles arranged as usual in a scalene triangle, and the setæ themselves are half as long as the body is thick; they are considerably shorter and finer than in Scoterpes.

The number of pairs of legs in the male is 47 in a specimen 8^{mm} in length, in the female there are 48 pairs. The sixth pair of legs of the male are somewhat longer and much swollen, the suture between joints 3 and 4 is very slight, the two joints together forming an ovate section of the leg a little thicker than the length of the second joint; terminal joint long and slender, considerably longer than joints 3 and 4 together. The 2-jointed eighth rudimentary pair of legs are longer and larger than in *Scoterpes copei*, the basal joint nearly twice as long, while the second (terminal) joint is larger and swollen, and besides being larger, ends in three or four fine minute setæ, instead of a short claw, as in Scoterpes. Length 8^{mm}.

The male genital armature is very minute and rudimentary, and has already been described in a general way; with but one species as yet known, it would be unsafe to assign their specific characters. The two inner laminæ are quite unequal in length and development, and the armature in general shows signs of degeneration, as though the species had originated from some form in which the male armature was more completely developed. Nine specimens were found by us in New Market and Luray caves, and about twenty in Weyer's cave, Virginia; Luray cave, Virginia (Dr. C. A. White, Ryder).

This species in size and general appearance would be easily mistaken for *Scoterpes copei*, which we at first, from a too hasty examination, supposed it to be. Mr. Ryder's excellent description characterizes the species, but his figures are indifferent, the third joint of the male is much more swollen in our specimens; and the normal leg (his fig. 3) is drawn too slender, while the front of the head is not correctly rendered. In our specimens drops of a yellowish secretion were attached in alcoholic specimens to the base of many of the setæ, indicating the presence of repugnatorial glands, though no pores could be found. On breaking the body in two nearly ripe eggs occurred in June; they were rounded, oval; length about $\frac{1}{3}^{mm}$.

NOTE ON THE GENUS CAMBALA OF THE FAMILY JULIDÆ.

CAMBALA Gray.

Julus Say, Journ. Acad. Nat. Sc. Phil., ii, 103, 1821.

Cambala T. E. Gray, Griffith's Cuvier's An. King, xiv, Insecta, i, pl. 135, fig. 2, 2a, 2b, 2c, no descr., 1832.

Reasia R. Jones, Todd's Cyclop. Anat. Phys., Art. Myriopoda, 546.

Cambala Gervais, Newport, Annals and Mag. Nat. Hist., xiii, 266, 1844. Aptères, iv, 137, 1847.
Spirobolus (in part) Wood, Mgr N. Amer., 212, 1865
Cambala Cope, Proc. Amer. Philos. Soc., xi, No 82, 181, 1869.

The essential, diagnostic characters of this genus are the linear eyes, the long slender body, with keeled scutes, while the antennæ are short and thick, much as in Spirobolus

The body consists of 59 segments, the scutes with high keel like ridges. The eyes are arranged in a linear row of ocelli, forming a straight line situated far behind the insertion of the antennæ, next to the front edge of the first segment. The front of the head is somewhat longer than broad; the surface full and convex as in Julus. Antennæ are short and unusually thick, more so than in Julus or Spirobolus, 7 jointed, joint 2 a little longer and thicker than 3, fourth shorter and more clavate than third, fifth rather thicker at end than fourth, but of about the same length; sixth thicker than any of the other, about as long as fifth; seventh very short, round, no longer than broad. The feet are slender, not quite so long as the body is thick. On the fourth lower large ridge is a whitish microscopic spot, which under a half inch objective is seen to be a short acute tubercle; these are Say's "stigmata," but they occur on each segment, and are doubtless homologous with the setiferous tubercles in Trichopetalum, etc.

The only species known has been mistaken for *Lysiopetalum lactarium* by Newport, Gray and Gervais, hence the synonymy of the two genera is somewhat confused. Newport, adopting Mr. T. E. Gray's *MS* name *Cambala*, was the first to characterize the genus, remarking, "I have derived the characters of this genus from the specimens originally sent by Say to Dr. Leach" It is probable that Say by mistake sent an example of his *Julus annulata* instead of a *L. lactarium*, as the two species would be easily confounded, although his *Julus annulatus* must have been of course familiar to him. The mistake was a natural one.

CAMBALA ANNULATA (Say) Cope.

Julus annulatus Say, Journ. Acad. Nat. Sc Phil, ii, 103, 1821.
Cambala lactarius T. E Gray, Griffith's Cuvier's Animal Kingdom, pl. 135, fig. 2, 2a, 2b, 2c. Insecta i, Vol. xiv, Vol ii, 784, 1832.
Cambala lactaria Newport, Annals and Mag Nat Hist., xiii, 266, 1844.
Cambala lactarius Gervais, Ann. Soc. Entom. France, 1844. Aptères, iv, 137, 1847.
Spirobolus annulatus Wood, Myr. N. Amer, 212, 1865.
Cambala annulata Cope, Proc. Amer Phil. Soc, xi, No 82 181, 1869. Trans. Amer Ent. Soc., iii, 66, May, 1870.

Body very long but blunt at the end, consisting of fifty-nine segments besides the head, eyes consisting each of six ocelli arranged in a straight line. The first segment behind the head is smooth, about half as long as wide,

evenly convex, considerably broader than the head; the three succeeding segments are of about the same length, and each are about half as long as the fifth and succeeding segments. On the first segment are about ten bead-like tubercles seen from above; on the third about eight longer tubercles can be seen from above; on the fifth and succeeding segments there are about nine dorsal and subdorsal high, prominent, thick, parallel ridges, becoming sharp behind. On the middle segments of the body about six sharp ridges with broad hollow valleys between can be seen from above. These are mounted on each side lower down by about twelve less distinct ridges, becoming towards the lower edge of the scuta less and less convex and distinct, until they are indicated by simple impressed lines. There are thus about thirty ridges in all on each scute. The segments (arthromeres) are short, and the smooth spaces between the rigid portions are very short above. The color of the body is horn-brown, the head, feet and antennæ pale flesh-colored, and there is a dark median spot on the vertex between the eyes. The ridges are darker than the rest of the body. Length 30^{mm}.

Little Wyandotte cave, Indiana; and Cave of Fountains next to Weyer's cave, Virginia (Packard), Zwingler's cave, Carter's cave, Kentucky (F. G. Sanborn). Spruce Run cave in the Kanawha river, Giles Co., Va. (Cope). One of the most abundant of the Myriopoda in the mountain region of Tennessee and North Carolina (Cope).

This species is not unfrequently found in caverns, where *L. lactarium* more rarely occurs. This well-marked species may readily be distinguished from *Lysiopetalum lactarium* by the very short, thick antennæ, linear eyes, and by the slenderer body, which, however, ends much more obtusely. We know of but one other species of Julidæ with the eyes arranged in a linear series; this is the *Trachyjulus ceylonicus* Peters of Ceylon, figured by Humbert.

The cave specimens which we have found are partially bleached, the result of probably a limited number of generations in the darkness.

On the Morphology of the Myriopoda. By A. S. Packard, Jr.

(Read before the American Philosophical Society, June 16, 1883.)

The following notes have reference to the hard parts especially of the diplopod Myriopods:

The Head. In the Chilognaths, which are the more primitive and in some respects the lowest group of the sub-class, the Pauropoda excepted, the structure of the head is on a much simpler type than in the Chilopoda.

The epicranium constitutes the larger part of the head; it may be regarded as the homologue of that of hexapodous insects. Of the clypeus of Hexapoda there is apparently no true homologue in Myriopods; in the Lysiopetalid Chilognaths there is, however, an interantennal clypeal re-

gion slightly differentiated from the epicranium and forming the front of the head. In the Chilopods there is no well marked clypeus; only a short, narrow transverse preantennal clypeal region to which the labrum is attached. Meinert, in his valuable and pains taking work on Myriopods designates what we here call the epicranium, the *lamina cephalica*; the division sometimes indicated in front next to the antennæ, he calls *lamina frontalis discreta*.

The labrum in the Chilognaths is a short, but broad, sclerite, very persistent in form, and not affording family or generic characters; it is emarginate on the sides, with a deep median notch containing three acute teeth. The labrum may on the whole be regarded as homologous with that of the Hexapoda, but is very broad and is immovable. Very different is the so called labrum of the Chilognaths, in which it consists of two parts, a central portion which may be homologized with the labrum of the Chilognaths, but is narrower, with a deep broad median notch at the bottom of which is a central stout tooth.

In *Orya barbarica* Gerv, according to Meinert, the labrum has a median suture, dividing it into two pieces, each with numerous fine teeth on the outer edge.

In *Dignathon microcephalum* Lucas (Meinert. Tab. ii, fig 15), and in *Geophilus sodalis* Bgs. and Mein, Meinert figures and describes the labrum as consisting of *pars media* and two *partes laterales*, distinctly separated by suture; no such differentiation as this is known to us as occurring in the labrum of Hexapods.

This labrum is flanked on each side by a transverse sclerite, much broader than long, these pieces may be called the *epilabra*; to the outer edge of each is attached the cardo of the so-called mandible (*protomala*). What we have for brevity called the *epilabra* (fig. 1) are the "laminæ fulcientes labri" of Meinert.*

The so-called mandibles of the Myriopods are the morphological equivalents of those of insects, but structurally they are not homologous with them, but rather resemble the lacinia of the hexapodous maxilla. For this reason we propose the term *protomala* (*mala*, mandible) for the mandible of a myriopod, *mala* would be preferable, but this has already been applied by Schiödte to the inner lobes of the maxilla of certain Coleopterous larvæ.

The protomala consists of two portions, the *cardo* and *stipes*, while the hexapodous mandible is invariably composed of but one piece, to which the muscles are directly attached, and which corresponds to the stipes of the myriopodous protomala. The stipes instead of being simply toothed, or with a plain cutting edge, as in Hexapoda, has, in the Chilognaths, two

* Myriapoda Musaei Hauniensis Bidrag til Myriapodernes Morphologi og Systematik. Ved Fr Meinert, af "Naturhistorisk Tidsskrift," 3 R. 7 B., Kjöbenhavn, 1871, p. 105 See Tab. i, fig 4 Meinert states that the laminæ fulcientes do not belong to the labrum itself, and that the form of these pieces varies greatly according to the species

outer unequal long teeth; and within, a series of singular processes like stout setæ edged with dense spines on the inner side. This double apparatus of teeth and spinose processes, which may be called the *pectinella*, gives the stipes a decided resemblance to that of the hexapodous maxilla. In the Chilopoda, according to the figures and description of Meinert, there is a greater variation in the nature of the pectinella of the stipes. As we have observed in the protomala of Scolopendra and Lithobius, there are three or more stout teeth, with an inner series of spinulated slender processes; but in several genera figured by Meinert, as *Mesocanthus albus* Mein., *Scolioplanes crassipes* Koch, *Chætechelyne vesuviana* Newp., *Geophilus sodalis* Bgs. and Mein., and *Mecistocephalus punctifrons* Newp., the cutting edge is provided with spinose processes alone.

For the second pair of mouth appendages of the Myriopoda we propose the term *deutomala*, or second pair of jaws. They form the so-called labium of Savigny and later authors. In the Chilognaths they have a superficial resemblance to the labium of winged insects; but the corresponding pair of appendages in Chilopoda are not only unlike the labium of Hexapoda, but entirely different in structure from the homologous parts in Chilognaths. The "labium" of Newport, or first maxillæ of Meinert, have been described and figured by those authors, to whose works the reader is referred.

The following remarks apply to the homologues of these parts in the Chilognaths. While most authors designate this pair of appendages as the "labium," Meinert more correctly calls them the first maxillæ, briefly in the Latin abstract of his "Danmark's Chilognather"* in his diagnosis of the order describing them as "*Stipites maxillares* appendicibus instructi, detecti;" but in his description of Julus referring to them as "Lamina labialis parva, stipites labiales modo partim sejungens."

Meinert also describes what he designates as a third pair of mouth-parts, or *labium*, which is enclosed by the second pair, behind which is a triangular plate (*lamina labialis*) which he regards as a sternal part, corresponding to the mentum of insects. He then adds: "In front of the labium in the Polydesmidæ are two short round styles (*stili linguales*), which are toothed at the end." He also speaks of the curved piece behind the laminia labialis, which he designates as the *hypostoma* (see our fig. 2).

It should be observed that Savigny states that the labium (lèvre inférieure) is in Julus composed of what he designates as the first and second maxillæ; his second maxillæ being Meinert's *labium*.

It seems to us that the researches of Metschnikoff† on the embryology of the Chilognaths (Strongylosoma, Polydesmus and Julus) leave no doubt that these myriopods have but two pairs of mouth-appendages, which Metschnikoff designates as mandibles and labium. The latter arises as a pair of tubercles or buds, at first of exactly the form of the man-

* Naturhistorisk Tidsskrift. 3 R. 5 B.

† Embryologie der doppeltfussigen Myriapoden (Chilognatha), Von Elias Metschnikoff. Zeitschrift für Wissenschaft. Zoologie, xxiv, 253, 1874.

dibles, and like the primitive embryonic mouth-appendages of any arthropod. Hence the differentiations of parts and coalescence of the two limbs while closely resembling that of the labium or second maxillæ of hexapods really occur in Myriopods in a different pair of appendages, *i. e.*, the second instead of the third pair. Hence the parts called labium (many authors) in Myriopods are really homologous with the first maxillæ of insects, and they should, to prevent misconception, receive a distinctive name (deutomalæ). With the aid, then, of embryology we have arrived at a clearer conception of the homologies of the second pair of mouth appendages in the Chilognaths. It forms a broad flat plate, becoming the floor of the mouth, and forming an under lip, it is differentiated into two sets of broad plates, an outer and inner stipes; the outer stipes (*stipes exterior*) bears on the free edge two movable toothed appendages, which may be designated as the inner and outer *malellæ*. The inner stipes (*stipes interior*), are united firmly, and are supported behind by what Meinert designates as the *lamina labialis*, behind which is a curved, broad sclerite called by Meinert the hypostoma; a rather unfortunate name, as it has been used by Meigen and Bouché for the clypeus of Diptera. Differentiated from the front edge of the inner stipes, is a piece usually separated by suture, which, as we understand it, is the *stilus lingualis* of Meinert; it is our *malulella*. A median portion of the deutomala has been apparently overlooked by authors, it is our *labiella* (fig. 2), and corresponds in a degree to the lingua of hexapods, it is a minute rounded piece situated between the malulellæ; in Julus minute and single, in the Lysiopetalidæ much larger, and divided into a large anterior, and a much smaller posterior crescent-shaped part; it is supported by two long cylindrical divaricating styles.

It thus appears that the head of Chilognaths bears but three pairs of appendages, viz., the antennæ, and the mouth-appendages, the proto and deutomalæ. Without doubt the Chilognaths, as proved by their embryology and morphology, and their close relationship with the Pauropoda, the simplest Myriopods, represent the primary form of the Myriopods, while the Chilopods are a secondary, less primitive group. Palæontology apparently supports this view. We may now turn to the structure of the head of Chilopod Myriopoda, which has been fully described by Newport,* and also by Meinert.†

Having already briefly described the morphology of the epicranium or antennal segment of Chilopoda, with the labrum and "mandibles" (protomalæ — "true maxillæ" of Newport), which are close homologues of those of diplopod myriopods, we may next take up the second pair of mouth appendages, which are the morphological equivalents of the so-called labium of Chilognaths. These, as seen in Scolopendra, are very different

* Monograph of the class Myriopoda, Order Chilopoda, with Observations on the general arrangement of the Articulata. By George Newport, Trans. Linn. Soc., xix, p. 287.

† Myriapoda Musæi Hauniensis Bidrag til Myriapodernes Morphologi og Systematik ved Fr. Meinert. Af Naturhistorisk Tidsskrift, 3 R. 7 B., 1871.

from the so-called under lip of Chilognaths; they are not united, and are separate, cylindrical, fleshy, 5-jointed appendages, but as Newport states "connected transversely at their base with a pair of soft appendages (*c, c*), that are situated between them, and which, as I have already stated, I regard as the proper *lingua*, as they form the floor of the entrance to the pharynx." These 5-jointed appendages are Mr. Newport's "maxillary palpi;" his true maxillæ being the homologues of the "mandibles" of Chilognaths.

The portion of the head of Scolopendra and other Chilopods, thus far considered, together with the antennæ and proto and deutomalæ, we consider as homologous with the entire head of Chilognaths; the basilar segment of Newport, and the two pairs of head-appendages have no homologues in the head of Chilognaths. They are rather analogous to the maxillipedes of Crustacea, and nothing like them, speaking morphologically, exist in other Tracheata. We therefore propose the term *malipedes* (*mala*, jaw; *pes*, foot, or jaw-feet) for the fourth and fifth pair of cephalic appendages of Chilopoda. At the same time it is easy to see that they are modified feet; especially when we examine the last pair in Scolopendra, which are attached to a true sternite, and see that they are directly homologous with the feet and sternite of the same animal.

The first pair of malipedes are the "labium and palpi" of Newport; the "first auxiliary lip" of Savigny. They, however, bear little resemblance to an insect's labium and labial palpi. They are separate, not coalescing in the middle as in the labium of Hexapods. The so-called labial palpi are 4-jointed, with an accessory plate. They arise directly in front of the "basilar segment" of Newport, but appear to have in adult life no tergite of their own.*

The second pair of malipedes or last pair of mouth-appendages, are the poison fangs; they are the "second auxillary lip" of Savigny; the "mandibles or foot-jaws" of Newport and subsequent authors. The dorsal plate, or what may be called the *second malipedal tergite* is the "basilar and subbasilar plate" of Newport.

As to the number of segments in the head of Chilognaths, both morphology and embryology prove that there are but three; in the Chilopoda five. Newport's observation on the young recently hatched Geophilus (his Pl. xxxiii, fig. 3), shows that the sub-basilar plate is the tergum or scute of the fifth segment; and the basilar plate is consequently the tergum of the fourth segment, or second malipedal segment. The sternite of the sub-basilar plate is usually a very large plate, deeply indented in front in the middle, with teeth on each side, and forms the "labium" of Newport. It may for convenience in descriptive zoölogy be termed the "pseudolabium."

* Balfour also states, as we find after writing the above, that the basilar plate is really the segment of the poison claws, and may fuse more or less completely with the segment in front and behind it, and the latter is sometimes without a pair of appendages (Lithobius, Scutigera) Comp. Embryology, 1, p. 225.

As embryological proofs of our morphological views may be taken th admirable researches of Metschnikoff* on the development of Geophilu His Taf. xx, fig. 4, shows plainly the four pairs of mouth-appendages be hind the antennæ, the latter developed as in Hexapods from the proc phalic lobes. His fig. 15 shows that the pleurum and tergum of two poste rior (or fourth and fifth) cephalic arthromeres, with their appendages, a the primitive scuta of the proto and deutomalar arthromeres which at th period have coalesced, and are intimately united with the procephalic lob His fig. 18 shows that at a later period the primitive scuta of the four cephalic segment has disappeared, or at least is merged into the fif primitive scuta or sub-basilar plate of the adult. An examination Metschnikoff's paper will prove conclusively that Newport's views to the sub-segments of the chilopods are not well founded in nature, a that they are merely for the most part simply adult superficial marking

The following table will serve to indicate, in a comparative way, th number of arthromeres in the head of the three sub-classes of Trache arthropods, their corresponding appendages, and the more important sy onyms:

	Hexapoda	Arachnida.	Myriopoda. (Chilopoda.)	Myriopoda (Chilognath
1st Arthromere (Preoral)	Antennæ.	Wanting.†	Antennæ.	Antennæ.
2d Arthromere (Postoral)	Mandibula.	Chelicerræ.‡ (Mandibles.)	Protomalæ. (Mandibles Savigny.)	Protomalæ. (Mandibles S vigny.)
3d Arthromere	1st Maxillæ.	(Pedipalpi. maxillæ.)	Deutomalæ (1st Maxillæ Savigny.)	Deutomalæ (Labium.)
4th "	2d Maxillæ.	1st pair of brenopoda.	1st Malipedes. (1st Auxiliary lip, Savigny.)	2d pair of Ped
5th "	....	2d pair of brenopoda.	2d Malipedes (Auxiliary lip, Savigny. Mandibles.)	3d pair of Ped
6th "	1st pair of brenopoda.	3d pair of brenopoda.	1st pair of Pedes	3d pair of Ped

General Morphology of the Body. The well known researches of Ne port on the development of Julus, and the embryological studies of Me schnikoff already referred to, show that the larva of Julus and other dip pod myriopods is hatched with but three pairs of feet. In *Julus terrestr* as stated by Newport, the 3d body segment is apodous, the 1st, 2d a 4th segments behind the head bearing feet. The number of body-segme are at first 9; the new segments appearing six at a time. In Strong

* Embryologisches, über Geophilus. Von Elias Metschnikoff. Zeitschrift Wissenschaft. Zoölogie, xxv, p. 313, 1875.

† Balfour claims that the 1st pair of cephalic apppendages are wanting, the fact shown by his Fig. 200 C, D, that the stomodæum at first lies between the procephalic lobes, and that the latter do not even bear appendages appears prove his statement.

‡ On the Organs of Reproduction and the Development of the Myriopo Phil. Trans., 1841.

losoma, according to Metschnikoff, the larva has eight segments behind the head, the second segment footless ; in Polydesmus there are but seven body-segments, the second apparently being apodous, though it is difficult to determine with certainty from the drawing which of the three first segments is apodous.

In two embryos of *Julus multistriatus* Walsh? kindly communicated to us by Prof. Riley, and which he assures us were freshly hatched right from the egg, the larvæ are much more advanced than in the freshly-hatched larvæ referred to ; still *the second body-segment is footless instead of the third;* but there are seventeen segments, the 1st, 3d and 4th each bearing a single pair of legs ; the 5th–10th segments each bearing two pairs of legs. In one of the three specimens, which was apparently a little longer out of the egg than the two others, there were five penultimate short secondary segments (11th–15th) on which there were rudiments apparently of but a *single pair of legs* to each segment, whereas Newport states that two pairs bud out from each segment, and while in *Julus terrestris* the new segments arise in sixes, in our species they arise in fives. In adult life a single pair of limbs arises from the second segment, and the first three segments each have but one pair of legs, the fourth having two as in the fifth and following segments.

It thus appears that the larval diplopod Myriopod is a six-footed Tracheate, though neither its mouth-parts nor primary legs are directly homologous with those of the Hexapodous insects.

Looking at the embryo diplopod Myriopod from a deductive or speculative point of view, it doubtless represents or is nearly allied to what was the primitive myriopodous type, a Tracheate, with a cylindrical body, whose head, clearly separated from the hind body, was composed of three cephalic segments, one pair of antennæ, succeeded by two postoral arthromeres, the protomalal and deutomalal arthromeres ; while the hind body consisted of as few as seven arthromeres, whose scuta nearly met beneath, with three pairs of six-jointed legs distributed among the first four segments. It is evident that the form represented by the adult is a secondary later product, and arose by adaptation to its present form. The embryo Geophilus, the only Chilopod whose embryology has been studied, leaves the egg in the form of the adult ; it has, unlike the diplopods, no metamorphosis. Its embryological history is condensed, abbreviated.

But in examining Metschnikoff's sketches, primitive Chilognath characters assert themselves ; the body of the embryo shortly before hatching is cylindrical ; the sternal region is much narrower than in the adult, hence the insertion of the feet are nearer together, while the first six pairs of appendages (the sixth apparently the first pair of feet of the adult) are indicated before the hinder ones. These features indicate that the Chilopoda probably arose from a diplopod or diplopod-like ancestor, with a cylindrical body, narrow sternites and with three pairs of legs, which represent those of the larval Chilognaths, the two anterior becoming the two pairs of malipedes of the present Chilopoda. Thus the first six appendages of the

embryo Geophilus correspond to the antennæ, two pairs of mouth-parts and three pairs of legs of the larval Julus.

The phenomenon of two pairs of limbs to a segment, so unique in Tracheata, may be explained by reference to the Phyllopoda among the Branchiata. The parallel is quite exact. The larvæ in both groups have but a single pair of appendages to a segment; the acquisition of a second pair in the diplopods is clearly enough a secondary character, and perhaps necessary in locomotion in a cylindrical body with no sterna.*

The larval Julus and the ancestral Chilognaths were hexapod Tracheata, but sufficiently different to indicate plainly that the Myriopods branched off from a much more primitive form than the Scolopendrella-like hexapod ancestor, and which form somewhat agrees with our hypothetical leptiform ancestor of all Tracheata.

The Myriopods also differ from Hexapoda in that the genital armature of the male (the females have nothing corresponding to the ovipositor of Hexapoda) is not homologous with that of true insects; moreover, the armature is not homologous with the limbs or jointed appendages of the myriopodous body. On the contrary, the apparatus of hooks arises from the sternum of the sixth segment, between, but a little in advance of the origin of the eighth pair of legs. It should be observed that the legs in Myriopods are outgrowths between the tergites and sternites, there being no pleurites differentiated, and in this important point also, the myriopods are quite unlike the Hexapodous Tracheates.

Affinity and systematic position of the Pauropoda. The nearest living forms which approaches the larval Diplopod are Pauropus and Eurypauropus. These organisms are practically primitive diplopods. Looking at the lowest Chilognath, *Polyxenus*, and comparing Pauropus with it, it will be seen that the latter scarcely differs from it ordinally. Pauropus has a head with a pair of antennæ and two pair of mouth-appendages, The antennæ are quite unlike any other myriopods, being 5-jointed and bifurcate, somewhat as in certain Coleopterous larvæ; the peculiar sense-filaments may be the homologues of the flattened sense-setæ at the end of the antennæ of Diplopod Myriopods.

The "mandibles" are rudimentary, very simple, and are scarcely more like Chilopod than diplopod protomalæ; there is a second pair of appendages which, as Lubbock states, are "minute and conical;" they bear a closer resemblance in position and general appearance to the "under lip" of Chilognaths, especially the under lip of Siphonophora; in fact, the

* It is plain that, as Balfour suggests, Comparative Embryology p. 324, the double segments have not originated from a fusion of two primitively distinct segments. There is, however, a misconception as to the nature of the "double segments." They are not so in fact. The scutes are single, undivided, but the ventral region is alone imperfectly double, bearing two pairs of appendages, just as single segments of Apodidæ may bear from 2-6 appendages; the differentiation is confined to the ventral limb-bearing region and limbs alone; the dorsal part of the segment does not share in the process.

mouth-appendages of Pauropus are much nearer the normal type of those of the true Chilognaths than the degraded mouth-organs of the Sugentia.

The body of Pauropus is cylindrical, the scutes are as much like those of Polyxenus as those of the Chilopods; the number of body segments is seven, the same as in the larvæ of certain Diplopods; the feet are 6-jointed as in Diplopods, and there are nine pairs, six pairs to the four penultimate segments. The three anterior pairs are developed from two segments, *i. e.*, arise from the ventral and lateral sclerites corresponding to two scutes. This fact should not, we venture to suggest, exclude them from the Chilognaths, as there is a considerable irregularity in the positions of the three pairs of anterior feet in larval Chilognaths. The terminal body-segment is much as in Chilognaths. When we examine the larva of Pauropus, we find a strong resemblance to the larval hexapodous Chilognaths. Hence we scarcely see good grounds for placing Pauropus in a distinct order from Chilognaths. Their distinctive characters, and they are important ones, are we submit, only of subordinate value, and we should therefore place the Pauropoda as the second sub order of Chilognaths, throwing all the genuine Chilognaths into a first sub-order.

Turning to Eurypauropus, we find that this singular form is in a degree a connecting link between Pauropus and Polyxenus; the head has much the same shape, the antennæ being inserted beneath far back from the front edge of the broad top; the legs are much the same shape, and more truly diplopod than in Pauropus, as they are arranged nearly in two pairs to a segment; there are six segments, four of them bearing legs, there being nine pairs of legs to four scuta. The scutes are much as in Polyxenus, spreading out flat on the sides, the animal being elliptical oblong, broad and flat. There are no true sternites like those of Chilopods, and though the feet are inserted wider apart, the entire structure of the soft, membranous sternal region is much as in Polyxenus. We therefore feel warranted, although originally accepting the ordinal rank of the Pauropoda, assigned them by Sir John Lubbock, in regarding them as Chilognaths, with aberrant features which would throw them into a suborder of the latter group.

The Systematic Position of Scolopendrella. This singular form is usually regarded as a Myriopod, while Mr. Ryder refers it to a distinct order, *Symphyla.* We have already* given our reasons for the view that it is a Thysanuran,† with only superficial resemblances to the Chilopod Myriopods. Our fresh studies on the latter confirm our opinion that the Scolopendrella is a hexapod. The mandibles and maxillæ, the former especially, are like those of the Thysanura, rather than the myriopods, not being divided into two parts (stipes and cardo). It seems to us that Scolopendrella with its numerous postcephalic legs may fulfill the

*American Naturalist, xv, 698, Sept. 1881.

†Compare the excellent figures of the mouth-parts of Scolopendrella in Dr. I. Muhr, Die Mundtheile in Scolopendrella und Polyzonium, 10er Jahresbericht über das Deutsche Staats Gymnasium in Prag-Altstadt, 1881-2. Prag. 1882.

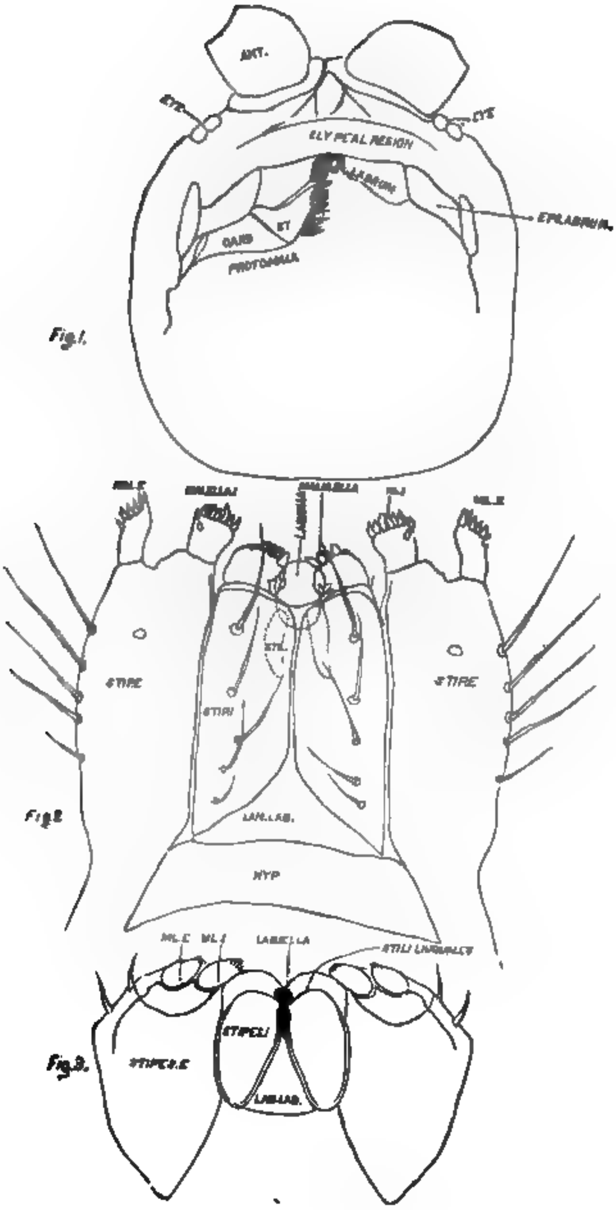
phylogenic requirements of the early embryo of Hexapoda and Arachn in which there are a number of embryonic primitive abdominal appe ages. Thus it preceded Campodea as a stem-form.

Genealogy of the Myriopoda. The pseudo-hexapodous larval forms Chilognatha, including the Pauropoda and the early germ of the Chilop (Geophilus), indicate that the many legged adults were derived from w we have called a Leptus-form ancestor. Our present knowledge of embryology of the Myriopoda shows that unlike the Arachnida and He poda the embryo is not provided with primitive, transitory legs. Th seems then no direct proof that the Myriopoda had an origin common w that of insects and arachnida, from a Scolopendrella like, and perhaps earlier Peripatus like ancestor; but from a six legged form, which, howev may have been derived from some worm like ancestor. The Leptus-fo larva of Myriopoda, with their three pairs of cephalic appendages and legs, may, then, be the genealogical equivalent of the six-legged Naupl of Crustacea; which type is generally believed to have originated fr the worms.

A genealogical tree of the Myriopods would then be simply t branches, one representing the diplopod and the other the single pai type (Chilopoda), both originating from a Leptus-like six footed ances (*i. e.*, with three pairs of cephalic and three pairs of postcephalic appe ages).

Dr. Erich Haase in his "Beitrag zur Phylogenie und Ontogenie d Chilopoden" publishes a "stammbaum der Protochilopoden." He pr poses a hypothetical group, Protosymphyla, from which the Symphy Thysanura and Chilopoda have originated But, as we have seen, this vi is based on mistaken views as to the relations of the Chilopods to the di lopod Myriopods, and of the homologies of Myriopods with insects As w have seen, the Chilopods must have originated from a Chilognathous stoc or at least from a branch which arose from Pauropus-like forms, and t Thysanura, with Scolopendrella, must have arisen from a separate m branch, which led to the Hexapodous branch of the Arthropod genealog cal tree.

For the reason stated, also, we should disagree with the views of Haec (Naturliche Schöpfungsgeschichte, 1870, 2d edit.) that the Diplopod M riopods were derived from the Chilopoda. In the English transacti (1876) he remarks. "But these animals also originally developed out of six-legged form of Tracheata, as is distinctly proved by the individual d velopment of the millipede in the egg. Their embryos have at first on three pairs of legs, like genuine insects, and only at a later period do t posterior pairs of legs bud, one by one, from the growing rings of the hind body. Of the two orders of Centipedes * * * * the round *doub footed* ones (Diplopoda), probably did not develop until a later period o of the older flat, *single-footed* ones (Chilopoda), by successive pairs of rin of the body uniting together. Fossil remains of the Chilopoda are first m tioned in the Jura period." The Chilognaths, however, as shown by Da



MOUTH-PARTS OF MYRIOPODS.

son, Meek and Worthen, and lately by Scudder, were numerous as far back as the Carboniferous period; the Chilopods are the later productions, perhaps not older than the Tertiary period, since Munster's *Geophilus proavus* is a doubtful form.

In this connection, reference should be made to the singular fossil, Palæocampa, from the Carboniferous formation of Illinois, originally described as a caterpillar-like form by Meek and Worthen, and later claimed to be a Myriopod by Mr. Scudder,* who proposes for the hypothetical groups, of which he considers it as the type, the name, *Protosyngnatha*. It seems to us, after a careful reading of Mr. Scudder's article, that this obscure fossil presents no features really peculiar to the Myriopods; but that there are as good or better reasons for regarding it as the hairy larva of some Carboniferous neuropterous insect. Mr. Scudder describes it substantially thus: "It is a caterpillar-like, segmented creature three or four centimeters long, composed of ten similar and equal segments, besides a small head; each of the segments, excepting the head, bears a single pair of stout, clumsy, subfusiform, bluntly-pointed legs, as long as the width of the body, and apparently composed of several equal joints. Each segment also bears four cylindrical but spreading bunches of very densely packed, stiff, slender, bluntly tipped, rod-like spines, a little longer than the legs. The bunches are seated on mammillæ and arranged in dorsopleural and lateral rows."

We do not recognize in this description any characters of a myriopodous nature; on the contrary, in what is said about the head, "composed of only a single apparent segment" (p. 165), and of the legs in the above description, and again on p. 165, where it is remarked: "The legs were different in form [from modern Chilopoda], but their poor preservation in the only specimen in which they have been seen, prevents anything more than the mere statement of the following difference; while the legs of Chilopoda are invariably horny, slender, adapted to wide extension and rapid movement, those of Palæocampa are fleshy, or at best subcoraceous, very stout and conical, certainly incapable of rapid movement, and serving rather as props," the author appears to be describing rather a caterpillar-like form than a Myriopod. It seems to us that the larvæ of the neuropterous *Panorpidæ*, with their two-jointed abdominal prop-legs, small head and singularly large spinose spines, arising in groups from a tubercle or mammilla, come nearer to Palæocampa than any Myriopod with which science is at present acquainted. For these reasons, and while the nature of these fossils is so problematical, we should exclude them, as regards the Myriopods, from any genealogical considerations.

We have also attempted to show that the *Archypolypoda* † are a subd

* The Affinities of Palæocampa Meek and Worthen, as evidence of the wide diversity of type in the earliest known Myriopods, by Samuel H. Scudder. Amer. Journ. Science, xxiv, No. 11, p. 161, Sept. 1882.

† The Systematic Positions of the Archipolypoda, a Group of Fossil Myriopods. Amer. Naturalist, 326, March, 1883.

vision of Chilognaths, allied not remotely to the Lysiopetalidæ; or at least that they are true diplopod Myriopods. Hence we are still reduced for our materials for a phylogeny of the Myriopods to existing orders, Pauropus being, perhaps, a more aberrant and stranger type than any fossil forms yet discovered.

EXPLANATION OF THE FIGURES.

Fig. 1. Head of Scolopendra, seen from beneath, showing the "mandible" (*protomala*) with its cardo (*card.*) and stipes (*sti.*), also the labrum and epilabrum.

Fig. 2. So-called under lip or deutomala of *Scoterpes copei*; *hyp.*, "hypostoma;" *lam. lab.*, lamina labialis; *stip. e.*, stipes exterior; with the *malella exterior* (*mal. e.*) and *malella interior* (*ml. i.*); the *stipes interior* (*stip. i.*), with its malulella; and the *labiella*, with its stilus (*stil.*).

Fig. 3. The deutomala of *Julus* sp.; the lettering as in Fig. 2. Author del.

Stated Meeting, May 18, 1883.

Present, 9 members.

President, Mr. FRALEY, in the Chair.

Dr. Heilprin, a newly-elected member, was introduced to the presiding officer, and took his seat.

A letter requesting a renewal of correspondence was received from the Egyptian Institute.

Letters of acknowledgment were received from the Royal Societies at Amsterdam and Munich.

Letters of envoy were received from the Egyptian Institute, and the Royal Academy at Munich.

Letters requesting No. 95 from the Manchester Literary and Philosophical Society, April 26; and requesting 102, 103, 104, from the Philadelphia College of Pharmacy, April 20, were read and referred.

Donations were received from the Egyptian Institute; Central Observatory at St. Petersburg; Royal Geological Insti-

tute and Anthropological Society at Vienna; Royal Academy and Observatory at Munich; the National Verein, at Bonn; Société de Géographie and Revue Politique at Paris; Société de Géographie Commerciale at Bordeaux; Royal Academies at Modena and Bruxelles; the Geographical and Geological Societies and London Nature; Literary and Historical Society of Quebec; Boston Natural History Society; Prof. C. A. Young; Numismatic, Antiquarian and Zoölogical Societies, at Philadelphia; the Library of Congress, Bureau of Education, Engineer Department, and the Philosophical Society, at Washington; the Chicago Historical Society; and the Brazilian School of Mines.

Photodynamic Notes, No. VIII, by Pliny Earle Chase, were read by title.

A note on the relic of the native flora of Pennsylvania, surviving in Perry county, by Professor E. W. Claypole, was read by the Secretary, and specimens of the plant, *Vaccinium brachycerum* Mich., were exhibited.

Minutes of the last meeting of the Board of Officers and Members in Council were read.

Mr. Fraley reported that, after conference with Dr. Brinton, he could recommend to the Society to accept the proposed gift. On motion, the recommendation was approved and adopted. (See MS. minutes.)

Pending nominations, Nos. 985, 986, and new nominations, Nos. 987 to 1004, were read.

A Committee of Five, to co-operate with other Societies in extending an invitation to the A. A. F. A. S. to hold their meeting of 1884 at Philadelphia, was appointed, consisting of Dr. Brinton, Dr. Barker, Mr. Lesley, Mr. Henry Phillips, Jr., and Mr. Wm. M. Davis. On motion of Dr. Frazer, the Committee was requested to ascertain if measures can be taken to secure the fixing of a date for the meeting of the Geological Congress at Berlin such as would permit those who have participated in the A. A. F. A. S. meeting to be present at the Congress.

And the meeting was adjourned.

Stated Meeting, June 16, 1883.

Present, 5 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Royal Academy at Lisbon (109, 110, 111), and Royal Academy at Amsterdam (109).

Letters of envoy were received from the Royal Academy at Lisbon, June, 1882; the Museum Teyler; the Société Hollandaise, March 30; the Royal Academy at Amsterdam, March 1; and the Surgeon General's Office, Washington, June 6.

Letters from M. J. Vidal, at Cairo; M. Gaston Planté, Paris; Dr. A. S. Packard, Jr., Providence, R. I.; Edmund Goldsmid, of Edinburgh; and Mr. A. R. Grote, of Buffalo, were read.

Donations for the Library were received from the Academies at Amsterdam and Rome; the Societies at Salem, Boston and Worcester; the Trigonometrical Survey of India; the Holland Society, and Museum Teyler; Dr. G. D. E. Weyer, of Kiel; the Geographical Societies at Paris and Bordeaux; Revue Politique, and Ecole des Mines; British Association, Victoria Institute, Royal Astronomical, and Antiquarian Societies and London Nature; Canadian Institute; Cambridge Museum; Medical Journal; New York Observatory; Rutger's College; Franklin Institute, Historical Society, College of Pharmacy, H. Phillips, Jr., and Dr. P. Frazer; American Chemical Journal; Smithsonian Institution, National Museum, Engineers' Department, Bureau of Education and Fish Commission; Wabash College; Medical Journal, at Indianapolis; and the Ministerio de Fomento.

The death of Col. Robert S. Williamson, at San Francisco, Nov. 11, 1882, was announced by Dr. Horn.

The death of the Hon. Judge George Sharswood, at Philadelphia, May 28, 1883, aged 73, was announced by Mr. Fraley.

Dr. A. S. Packard, Jr., of Providence, R. I., communicated, through Prof. Cope,—

1. A revision of the *Lysiopetalidæ*, a family of Chilognath myriopoda; with a notice of the genus *Cambala*. (See page 177, 195.)

2. On the Morphology of the *Myriopoda*, with a plate. (See page 197.)

Mr. A. R. Grote, of Buffalo, communicated: An Introduction to the North American *Noctuidæ*. (See page 134.)

Pending nominations, Nos. 985 to 1004, were read.

And the meeting was adjourned.

Stated Meeting, July 20, 1883.

Present, 4 members.

Curator, Dr. HORN, in the Chair.

Letters of acknowledgment were received from the Royal Library, Berlin (112); the Würtemberg V. N. V. (109, 110, 111); the Prague Observatory (107, 108, 109); New Hampshire Historical Society (113), Essex Institute (113), American Antiquarian Society (113), Rhode Island Historical Society (113), Connecticut Historical Society (113), W. D. Whitney (113), New Jersey Historical Society (113), Buffalo Society of Natural Science (113), W. B. Taylor (113), Theodore Gill (113), Wisconsin State Historical Society (113), and Georgia Historical Society (113).

Letters of envoy were received from the Society of Sciences at Bordeaux, the Hungarian Academy, Lisbon Academy, Belgian Ministry of Foreign Affairs, and Institut Ethnographique at Paris.

Donations for the Library were received from the Royal Academies of St. Petersburg, Berlin, Vienna, Buda-Pest, Munich, Brussels, Lisbon; from the Societies at Bremen, Emden, Batavia, Stuttgard, Bordeaux, Dublin; from the Observato-

ries at Prague, Offenbach, Geneva, New York; from the Royal Museum at Brussels; Geographical, Anthropological and Ethnological Societies at Paris and Bordeaux; Revue Politique, Annales des Mines, Musée Guimet, Revista Euskara, Royal Astronomical Society, Museum at Rio de Janeiro, New Zealand Institute, Boston Natural History Society, New Bedford Library, Yale College, Brooklyn Library, Prof. Guyot; Franklin Institute, College of Pharmacy, Library Company; Peabody Institute, United States Naval Institute, Smithsonian Institution, National Museum, Bureau of Interior, and Fish Commission.

The death of Prof. Stephen Alexander, at Princeton, N. J., June 25th, aged 76, was reported.

The death of Prof. Charles E. Anthon, at New York, in June, aged 60, was reported.

The death of Major-General Sir Edward Sabine, in England, about May 28, aged 95, was reported. (See London Nature for July 5, p. 218.)

The election for new members was postponed to October 19th.

And the meeting was adjourned.

Stated Meeting, August 17, 1883.

Present, one member.

Curator, Mr. Henry Phillips, Jr.

Letters of acknowledgment from Harvard College Library (112); the Wyoming Historical and Geological Society (113); the Royal Academy at Copenhagen (110, 111); Mr. Phillips (113), and the Numismatic and Antiquarian Society of Philadelphia (113).

Letters of envoy from the R. Accademia dei Lincei, the Geological Survey of India, the Royal Society at Liège, the Cambridge Philosophical Society, and the Musée Guimet.

Donations to the Library from the Indian Survey; Royal Society at Tasmania; Imperial Academy at St. Petersburg; Imperial Society at Moscow; Imperial Geological Institute at Vienna; German Geological Society, Berlin; Royal Academy, Brussels; Statistical Bureau, Stockholm; Antiquarian Society, Copenhagen; Royal Academy and Observatory at Turin; Accademia dei Lincei, and Geological Committee at Rome; International Geological Congress at Bologna; Geographical Society, Annales des Mines and Revue Politique at Paris; Geographical Society, Bordeaux; Revista Euskara; Nautical Almanac, Barcelona; Scientific Expedition, Lisbon; Royal Institution, Victoria Institute, Royal Astronomical Society, Royal Geographical Society, Meteorological Society, Geological Society, Royal Asiatic Society, and London Nature; John B. Lawes, of Herts, England; W. J. O'n Daunt, of Dublin; Museum of Comparative Zoölogy, Cambridge; American Journal of Science; New York Observatory; C. A. Barratoni, Ed. of Travel, N. Y.; Franklin Institute, Academy of Natural Science, American Journal of Pharmacy, and Prof. E. D. Cope; the Wyoming Historical and Geographical Society; American Chemical Journal and Journal of Mathematics; National Academy of Sciences; Polytechnic Society of Kentucky, Louisville; State Library of Natural History, Illinois; American and Oriental Journal; and Museo Nacional.

And the meeting was adjourned.

Stated Meeting, September 21, 1883.

Present, 3 members.

President, Mr. FRALEY, in the Chair.

A letter was received from Mr. J. B. Lawes, dated Rothumstead, Herts, England, July 31, 1883.

Letters of acknowledgment were received from the Astronomico Observatorio Nazional de Facubaya, Mexico (113)

Prof. J. J. Stevenson (113); and the Cambridge University (109).

Letters of envoy were received from the Prussian Academy, Swiss Society, Belgian Statistical Bureau, Musée Guimet, Institut d'Ethnographie, Greenwich Observatory, and United States Coast Survey.

A letter requesting information was received from the United States Signal Service Bureau.

A letter requesting the completion of their set of Transactions of the American Philosophical Society was received from the London Statistical Society. So ordered.

A letter proposing full exchanges from the beginning was received from the United States Geological Survey, Washington, D. C. So ordered.

Donations for the Library were received from the Prussian, Bavarian, Belgian, Turin, Modena and Madrid Academies; from the Institutes at Venice and Philadelphia; from the Adelaide, Greenwich, Radcliffe, Yale and New York Observatories; from the Statistical Bureaus at Stockholm and Brussels; from the Societies at Hanover, Glarus, Leipsig, Görlitz, Lausanne, Leeds and Boston; from the Historical Societies at New York and Newark; from the Geological Societies at Vienna, London, Glasgow and Dublin; from the Geographical Societies at Paris, Bordeaux and London; from the Zoölogical Societies at Paris and London; from the Antiquarian Societies at Paris, London and Worcester; the Ethnographical and Anthropological Societies at Paris, the Society of Americanists, Ecole Politechniqué, Bureau des Longitudes, M. Loewy, and the Revue Politique; the Musée Guimet, Revista Euskara; Expedition Serra Estrella; Office of Mines, Victoria; London Nature, Canadian Naturalist; American Journal of Science; American Journal of Pharmacy, Pennsylvania Magazine of History and Biography, the Engineers' Club, Dr. Hugh Hamilton, Dr. Charles W. Dulles, and Mr. Henry Phillips, Jr., of Philadelphia; Johns Hopkins University and the University of Virginia, the United States Naval Institute; the Smithsonian Institution, United States Board of Engineers, Signal

Service, Coast Survey, National Museum and Fish Commission; C. O. Thompson, of Terre Haute; Dr. Ladislaus Netto, George Basil Digwell, and the State Geological Survey of Illinois.

The death of John C. Trautwine, at Philadelphia, September 14, 1883, aged 74, was announced by the Secretary.

The following communications were read:

From Prof. E. W. Claypole, New Bloomfield, Perry county, Pennsylvania:

1. On a large *Crustacean* from the Catskill rocks of Meshoppen, Wyoming county, Pa., in the collection of Mr. Lacoe, of Pittston, Pa., with a small photograph of the head; a plaster cast of which was exhibited.

2. On the genus *Rensselaeria* in the Hamilton group, in Perry county, Pa.

3. On the equivalent of the New York *Portage*, in Perry county, Pa.

From Prof. E. D. Cope, a letter to the Secretary, dated Sully Springs, Dakota, Sept. 7, 1883, was read, as follows:

"I have the pleasure to announce to you that I have within the past week discovered the locality of a new lake of the White River epoch, at a point in this Territory nearly 200 miles north-west of the nearest boundary of the deposit of this age hitherto known. The beds, which are unmistakably of the White River formation, consist of greenish sandstone, and sand-beds, of a combined thickness of about 100 feet. These rest on white calcareous clay, rocks and marls, of a total thickness of 100 feet. These probably also belong to the White River epoch, but contain no fossils. Below this deposit is a third bed of drab clay, which swells and cracks on exposure to weather, which rests on a thick bed of white and gray sand, more or less mixed with gravel. This bed, with the overlying clay, probably belongs to the Laramie period, as the beds lower in the series certainly do.

"The deposit as observed, does not extend over ten miles in north and south diameter. The east and west extent was not determined.

"The fossils, which indicate clearly the age of the formation, are following:

PISCES.

Rhineastes, sp. nov.	}	2
Aminurus, sp. nov.	}	

LACERTILIA.

Sp. indet 1

TESTUDINATA.

Trionyx, sp.	3
Trionyx, sp.	
Stylemys, sp.	

RODENTIA.

Castor, sp. 1

CARNIVORA.

Galecynus gregarius	3
Hoplophoneus, sp.	
? *Hoplophoneus*, sp.	

PERISSODACTYLA.

Aceratherium, sp.	3
Aceratherium, sp.	
Anchitherium, sp.	

ARTIODACTYLA.

Elotherium ramosum	7
Hyopotamus, sp.	
Oreodon, sp.	
Oreodon, sp.	
Oreodon, sp.	
Leptomeryx, sp.	
Hypertragulus, sp.	

Total species 20

"Interesting features of the above catalogue are: The absence of Hyracodon and Poebrotherium, so abundant in the beds of this age elsewhere; the presence of fishes, not hitherto detected in them; and the presence of the genus of tortoises, *Trionyx*. The latter genus has not hitherto been found in our Western lacustrine beds of later than Eocene age; while they are abundant in our modern rivers. This discovery partially bridges the interval. The same is true of the fishes mentioned, which represent the order Nematognathi."

From Mr. Joseph Lesley, a letter to the Secretary, dated Princeton, Mass., August 22, was read, and specimens of seeds exhibited which had germinated between blocks of ice in the ice-house attached to the hotel of Mr. Edwin Grimes.

"In 1882 Mr. Grimes noticed that seeds, which had been dropped in packing the ice, had thrown out stems and roots. In the winter of 1882-'83, he experimentally scattered seeds of rye, barley and wheat be-

tween the cakes. To-day (Aug 22) I was called to look at some of t results, and I send you a rough drawing of one of the germinated r seeds. You will notice that the roots pushed out laterally between t blocks of ice, the shoot, or stem, did the same for half an inch, but th turned upwards at a right-angle and penetrated the solid ice vertically a distance of two inches.

"No matter how the seed lay, whether with its germinating point u down or sideways, the growth was always in the true vertical through t solid ice.

"I have seen, in 1882 and 1883, at least fifty similar cases occurring this ice-house."

Pending nominations, Nos. 985 to 1004, and new nomin tions, Nos. 1005, 1006, were read.

The President reported that he had received, and paid ov to the Treasurer, $132.75, being the interest on the Michau rentes, last due.

And the meeting was adjourned.

The Perry County Fault. Note on an important Correction in the Ge logical Map of Pennsylvania. By E. W. Claypole

(Read before the American Philosophical Society, April 20, 1883.)

THE DISTRICT IMMEDIATELY SOUTH OF NEW BLOOMFIELD.

The country lying immediately south of Mahanoy ridge, is one the best collecting grounds that I have found in the county for the foss of the Hamilton and Chemung groups. The Upper Hamilton shales a there exposed better than I have found them elsewhere, and the Chemun especially the lower part of the group, may also be examined in ma small wayside cuts and field-exposures.

But very soon after beginning to work this field I became aware th some difficulty hitherto unrecognized stood in the way of deciding t horizon from which the fossils came. It was impossible to recognize t different rocks according to the views expressed in the preliminary map Perry county. References to this geological map of the county will sho that the ground between Mahanoy ridge and Dick's hill is there repr sented as a close syncline bounded by outcropping edges of Hamilt sandstone, the middle of which is occupied by a sheet of Chemung roc But a very short examination sufficed to show that the Hamilton Upp shales extended much farther out into the valley from Mahanoy rid

The New Bloomfield fault.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1. Cross-section of the faulted district.
Fig. 2. Diagrammatic section across the fault.
Fig. 3. Copy from the published map of Perry Co.
Fig. 4. Corrected representation.

F. 2.

than the bounding line drawn on the map. Hamilton fossils were found farther and farther out from the ridge in the grounds represented as Chemung on the map, until it become evident that in the western part of the basin or trough the Hamilton Upper shales were repeated by the extension to the eastward of one of the anticlines represented at the end of the trough. Crawley hill is a mass of Hamilton sandstone rising immediately to the south of the township road running to Little Germany at a point not more than three miles from Bloomfield. The influence of this anticline is to bring up the Hamilton Upper shales again to the surface so that the lower beds crop out at or near the school-house on the branch road to the south. Continuing along the branch road these Hamilton shales still occupy an immense space, far more than their thickness, and yet they dip very steeply. Another anticline, running up from the south-west, produces another repetition. The crest of the Hamilton Sandstone ridge which encloses on the east the Perry Furnace valley throws up the upper shales again, so that in passing south, about half a mile from the New Bloomfield and Little Germany road, one passes over two anticlines rising first to the top layer of the Upper Hamilton shales or perhaps even into the Genesee, then descending to the edge of the Hamilton sandstone, again rising over the syncline and again descending on the second anticline. Nor is it until both the ridges have been passed over that one finds the strata regularly dipping outwards at an angle of almost 90° from the last anticlinal axis.

The consequence is that the Chemung rocks do not occur, as represented upon the map, along the middle of the eastern part of the valley. The whole of this area is occupied by Hamilton shales. The area, colored to represent Hamilton rocks on the map, between the roads leading to Perry Furnace and to Gibson's rock is occupied by rocks of later date. Most of them are the equivalents of the Portage-Chemung, very similar in appearance.

In fact, among the slight though rather numerous exposures of shale occurring in this valley, it would be almost impossible without the assistance of palæontology to determine their different horizons. Even with this aid, the difficulty, although diminished, is not removed. Many of the beds are totally barren ; but, by the study of the fossils yielded by others the folds and varying angles of dip were followed out and Chemung fossils and rocks were found to occupy the whole southern side of the Middle basin, close up to the foot of its bounding range, Dick's hill and Iron ridge. Inasmuch as the base of these hills is in many places occupied by limestone, it is evident that two so distant horizons can only be brought into contact by a fault.

Following the various roads out of New Bloomfield it is not difficult to trace this fault through the county.

No. 1. The Ridge road to Carlisle. On this line the successive formations occur in regular sequence from New Bloomfield for about two and one-half miles, when the ground suddenly changes from Chemung shale to Lower Helderberg limestone.

No. 2. Old road to Carlisle. The same result is obtained along this line. At about two miles from New Bloomfield is a small roadside cutting showing Chemung shale and at about one hundred yards further on is an indistinct but manifest Oriskany ridge. Between the two is a narrow strip of Lower Helderberg limestone.

No. 3. West road to Gibson's rock. At about two miles and a half from New Bloomfield, the lower Portage bed (Cardiola shale) dipping at nearly 90° crops out on the roadside, and within one hundred yards the road passes over the Oriskany sandstone (near Mr. S. Brown's).

No. 4. Road to Montebello narrows. This road, running almost due west, passes over a great distance of Chemung shales rising to a higher horizon than along either of the roads already mentioned. But on turning to the south at the entrance to the narrows two cuttings, only one hundred and fifty yards apart, show the Chemung shales and the lower Helderberg limestone.

No. 5. Road from Perry Furnace to Gibson's rock. The old Perry Furnace lies upon the lower Helderberg limestone. The Oriskany sandstone does not make any conspicuous ridge along this road. But at a few hundred feet south of the Furnace the base of the Hamilton sandstone is seen and passing through the narrows its upper limit may be easily detected. Following this at a distance of about four hundred feet comes in the Oriskany sandstone, forming a distinct ridge of rocks. The fault therefore comes through in this interval, bringing the Lower Helderberg limestone in contact with the Hamilton Upper shale. The throw here is less than farther east, not exceeding 1650 feet measured at right angles to the beds, or 2300 feet if measured vertically.

No. 6. Road to Losh's run (Polecat road and Ohio Wharf road). This road strikes the line of fault about six miles east from New Bloomfield. The exposures are not quite so striking as in the places already mentioned, but the fault is equally conspicuous. Chemung shales occupy the ground south from Mahanoy ridge to Dick's hill with, so far as can be determined, a tolerably uniform dip of about 40°. Immediately at the northern foot of Dick's hill the lower Helderberg limestone is quarried. Though no cutting showing the shales can be seen close to the quarry, yet the surface of ...fields shows the presence of the Chemung sandstone, and, from the ... it is apparently nearer the top than the bottom of the group. Some ...ations also are present, which seem to show that the yellow shales and ...n sandstones of the beds underlying the limestone, are brought up into ...t with the Chemung. The throw of the fault here is consequently ...r than at any one of its western exposures, amounting, if measured ... across the beds, to about 4650 feet, or vertically 6510 feet.

...stward of the lines hitherto followed the fault may be traced. It ...d the Hamilton sandstone of South Furnace ridge, which declines in ...ence to the general level of the country. This extinction of the ...ton Sandstone ridge takes place about two miles south west of the

Perry Furnace. It cuts through the Oriskany ridge, almost at the point where the two outcrops are about to meet, and passing out of the Oriskany near the high point behind Adam's Glen school-house, near Landisburgh, cannot be followed through the monotonous red shale, of which the valley consists. There is, however, no ground for supposing that it continues into the Blue mountains, no traces of displacement being visible in Kennedy's valley or on Pilot Knob.

Eastward beyond the display near Montebello narrows, described above, the fault continues, and its investigation becomes difficult. After leaving the exposure at No. 6, which is about a mile east of the narrows, and where the throw is greatest, it suddenly diminishes. The Hamilton sandstone which has been faulted up and has formed the monoclinal ridge of Dick's hill, suddenly sinks and vanishes underground. The land being low it is not easy to find evidence of its presence, but sections along the river and in Watts township show that it continues to Half Falls mountain.

From the facts that have been collected the only possible conclusion is that the fault here doubles itself and rapidly diminishes. The line already traced continues nearly along the course of Losh's run and forms the most southern of the four separate ranges of Hamilton sandstone, which together form Half Falls mountain. About the meridian line on which the sudden descent of the Hamilton sandstone takes place and Dick's hill disappears, a subsidiary fault develops itself about half a mile northward, near the end of Mahanoy ridge and continues to and across the river where it throws up a third ridge of Hamilton sandstone immediately south of the second and nearly equaling it in height.

These two minor faults—extensions of the Perry County fault—run westward along the range of Half Falls mountain to a distance which it is not possible to determine without a greater expenditure of time than the other work on the county would justify. The southern fault probably has but a short range, but the northern not improbably runs for two or three miles.

The fault here described is thus shown to be one of no trifling extent, having been traced in the above notes about eighteen miles along its outcrop from E.N.E. to W.S.W. The changes which it renders necessary on the map are considerable. The whole outcrop of the Hamilton rocks ranging along the north side of Dick's hill must be canceled and its place occupied by Chemung shales. The great patch of Chemung shales in the western end of the valley must be replaced by Hamilton and the Hamilton by Chemung. These changes may be seen in a moment by comparing two sketch maps accompanying this paper with one another. The narrow middle valley of Perry county is not a syncline but a monocline. Half of it has been removed and elevated above the level of the rest, from which height it has been washed by atmospheric action and swept into the Atlantic.

The mass of material thus removed will be evident when the diagram shown below is compared with the maps and with the figures showing the amount of "throw" of the fault. This section, though not

drawn minutely to scale is yet sufficiently accurate for our present purpose. It occurs at Montebello narrows about four miles from New Bloomfield and shows what would be seen, if the exposure of the rocks permitted, along the whole course of the fault. The details, such as the amount of throw and the horizons brought into juxtaposition, would vary to some extent, but these variations do not in any way affect the principle.

The fault is indicated on the surface only by a slight and interrupted depression, not in any way noticeable; but along at least a part of its course it is marked by a line of strong springs. So evident is its course, when the structure of the county is understood, that a man can stand with one foot on the Chemung shales and the other on the Lower Helderberg limestone.

Throw.—In estimating the throw of this fault it must be remembered that it is not everywhere of the same extent. At its greatest the olive shales of No. 8, the Chemung, are brought into contact with the limestone of No. 6, the Lower Helderberg. If we then calculate the throw where it is greatest we shall get the following results. The part of the Chemung appearing at the surface at the fault is as near as I can determine about 2000 feet above the base of that group, including the Portage:

				Feet.
Partial	thickness	of	Portage-Chemung (lower portion)	2000
Total	"	"	Genesee shale	200
"	"	"	Hamilton Upper shale	300
"	"	"	Hamilton sandstone	600
"	"	"	Lower Hamilton shale	500
"	"	"	Marcellus Black shale	100
"	"	"	Marcellus limestone and shale	50
"	"	"	Oriskany sandstone and shale	100
Partial	"	"	Lower Helderberg limestone	200
Total	"	"	rocks thrown by the fault	4050

This, within certain small limits of error, is the amount of throw calculated at right angles to the bedding. The total dislocation is, however, much greater. The tangential or horizontal thrust, to which is due the folding of the Appalachian strata and their accompanying or subsequent fracture, forced the the rocks on the S. E. side of the fault over those on the N. W. side, along a slope whose angle cannot be determined. It has been represented in the section at 45°, but was probably less. If the amount above given be now increased in the proportion of the sine of this angle to the radius, or multiplied by about 1.4, we shall obtain as the actual displacement of the strata along the line of the fault about 5600 feet.

The Little Germany Fault.

Further investigation has developed another fault parallel to the first and at the distance of about a mile to the northward.

It develops itself near the hamlet of Little Germany, in Spring township, and runs east-north-east into Centre for nearly five miles. Though

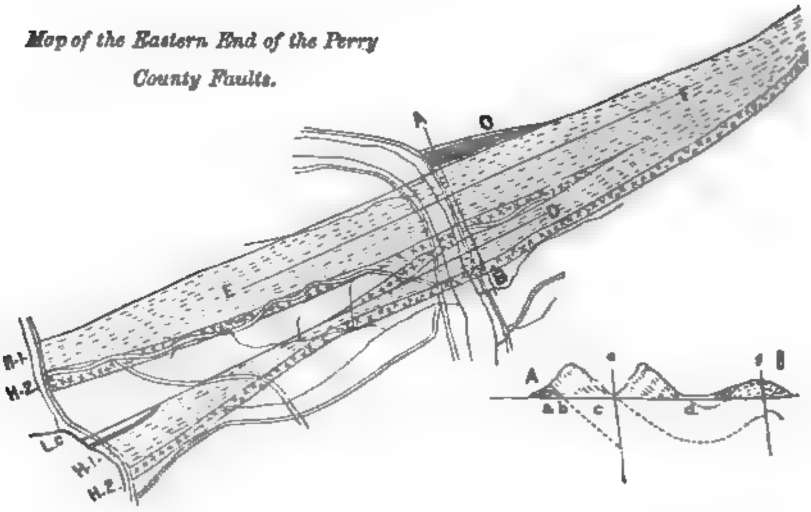
far inferior in length and throw to the Perry County fault it yet produces much complication and several noteworthy changes in the topography and landscape.

The most westerly point at which I have been able to detect the fault is on the hill west of Little Germany, where it produces a fork in the Oriskany sandstone, one ridge continuing on its previous course, while the other diverges slightly to the southward. The latter thrown up by the fault is cut off at a short distance, the ridge terminating in a field.

In thus bringing up the Oriskany to the surface, the dislocation has also brought up the Lower Helderberg limestone adjoining it, and the result is that limestone has been quarried and burnt at one place, while at the distance of about 100 feet northward, or geologically speaking *below* it, lies

FIG. 5.

Map of the Eastern End of the Perry County Faults.



H. 1. Hamilton sandstone and Lower shale. — L. Limestone.
H. 2. Hamilton Upper Shale. — E. F. Fault.
O. Oriskany, &c. — C. D. Fault.

the Marcellus Black shale with no intervening Sandstone ridge. The Marcellus thus occurs on *both* sides of the narrow belt of limestone. Following the line of fault a little farther to the east, we find the Lower Hamilton shale brought up on the south side against the Marcellus on the north, and farther yet the lower shale, about 500 feet thick, occupies both sides of the fault. As we approach the township line, which lies on the watershed parting the south fork of Montour run from the tributary of the Little Juniata, a high connecting ridge of Lower Hamilton shales rises on the south side of the fault, exposing the Marcellus at its base, into which a tunnel six feet square in section has been driven in search of coal.

The north side is occupied by the Hamilton sandstone, through which the fault here cuts obliquely and the throw having increased it causes a lateral displacement of nearly a mile, through which the road passes from the Lower to the Upper shale without crossing any Sandstone ridge.

Entering Centre township, the fault passes along the strata as they rise to the Crawley arch, leaving the synclinal west end of Mahanoy ridge separated from the anticlinal east end of Crawley hill. The latter is so far eroded as to expose the Hamilton Lower shale for more than two miles from Little Germany.

The throw is greatest near the watershed on the township line, where the lower part of the Lower Hamilton shale is brought up against the Upper Hamilton shale and may be estimated thus:

Upper Hamilton shale (part)	150	feet.
Hamilton sandstone	600	"
Lower Hamilton shale (part)	400	"
	1150	

But as the beds dip at about 45°, the actual vertical displacement is more, being in proportion to the sine of the angle of dip. This will give 1600 feet. The Little Germany fault extends into Centre township almost to Bloomfield, gradually dying out. But it may be traced by a slight valley, and by the increased thickness of the Hamilton Upper shale, as far at least as the residence of Mr. William Brunner. Its total length is about four and a half miles.

Intermediate Fault.

Yet further in this connection, a third fault of small dimensions passes between the two above described. Manifesting itself near the house of Mr. George Meck, it causes a repetition of the Hamilton sandstone, bringing the middle and upper beds to the surface after they have dipped south from the Crawley anticline.

This fault is of no great extent, apparently disappearing in a mile and a half. Nor is its throw more than about 200 or 300 feet. But it makes a distinct short ridge of Hamilton sandstone, and a deep intervening valley between it and Crawley hill.

N. B.—In consequence of the discovery of this third dislocation, a slight correction is rendered necessary on the map representing the eastern end of the Perry County fault. The middle one of the three short anticlines there represented, is the small ridge thrown up by the third fault, and is therefore monoclinal, with south east dip, and not anticlinal in structure.

Note on a relic of the Native Flora of Pennsylvania, surviving in Perry County. By E. W. Claypole.

(Read before the American Philosophical Society, May 18, 1883.)

One of the inevitable, but, to the biologist, deplorable consequences of the spread of cultivation, is the extinction of many of the native or wild species of plants and animals. Could we have complete catalogues of the original flora and fauna of any country where nature has been long and entirely subjected to man, we should find many a name which would to us represent no existing being. It would be the name of a member of the aboriginal races which had proved unable, essentially or accidentally, to maintain its ground in the changed circumstances against its former companions, and had consequently died in the struggle. Or it might be, in the case of America, the name of one that, though able to hold its own against all its native competitors, failed in the contest with some of the new species introduced from more highly developed Europe, where for centuries the struggle has been more intense than here. In either case the result has been the same to the species—ultimate extinction.

It is a notorious fact in geology and botany, that many animal and vegetable species from the Old World have crossed the Atlantic in the traces of the white man, either as his friends or his foes, and have squatted on the lands of America, and made themselves as completely at home here as in Europe, some of them much more so. Without entering into the subject at any length, it may suffice to mention among the former, the house fly, the honey bee, the brown rat, the cabbage butterfly, the English sparrow, the currant and apple worm, the wheat midge, and, though some have disputed this, the Hessian fly. Among the latter may be named the white weed, the purslane, the carrot, the parsnip, the chicory, mullein, toadflax, catnip, &c., &c. All these have proved themselves fully competent to hold their own against the native races of America, and even to conquer them by one means or another in the struggle for existence.

Cultivation, however, is a more deadly foe than competition to many of our native species. The axe and the plough change the conditions of life so suddenly and so greatly that many a plant and animal are deprived at once of both food and shelter. Confining our attention now to the former, the plants, we may notice two or three principal causes of the destruction of some of our aboriginal species.

1. The loss of shade resulting from the destruction of timber. The plants of our woodlands and forests cannot all endure the brilliant blazing sun that pours down upon them when the trees are felled. The direct heat seems fatal to many. The resulting drought destroys more. The moisture-loving ferns, without exception, dislike the sunshine, and though some of them, such as the common polypody, do not require much water, yet they shrivel and die when deprived of shade. It is not too

much to say that were it not for cool, moist glens and caves, where plough and ploughman can never come, many of these beautiful plants, the loveliest ornaments of the herbarium and the garden would have long since disappeared from the land. As it is, many of them, both here and in Europe, are almost extinct. They linger on, their lives hanging by a thread, which accident, or the hand of a ruthless collector, or of an over-eager botanist, may at any time snap asunder. Such are the elegant Killarney fern in Ireland, and the Trowbridge fern in England, and such may before long be the condition of the Hartstongue and the Climbing fern in this country.

2 The competition of native races, and of introduced species under the new conditions, is another element in the problem. Enough, however, has been said above on this point.

3. The cultivation of the ground is a most potent factor in the destruction of many native species. Few, except annual plants, can long survive this incessant disturbance of their roots Of these consist, for the most part, our weeds But the perennial species, especially those which require several years to produce seed, and then produce it sparingly; those that are choice of soil and conditions, cannot maintain themselves under cultivation, and soon fail and die.

There are certain species, I may say certain groups, which are less tolerant of man and the conditions which he introduces than others. The gap between them and civilization seems wider than it is in other cases. They are the real "wild" flowers which cannot be tamed, and usually die if the attempt to tame them is made. Like the wild Indian tribes of this continent, who are so far removed from the white man and his ways that their civilization seems scarcely possible, these "wild" denizens of our "wild land" refuse to acknowledge man's supremacy, and die if he tries to assert it.

Among these truly wild flowers are many of the HEATH FAMILY, specially attached to the moor and the forest. Their very name is synonymous with wildness and freedom The heather of Scotland brings up vividly the breezy moor and brae and fell. It is an emblem of the "land of brown heath and shaggy wood" But the Scotch heather, like many of its relations, refuses to be confined within the garden fence. It is difficult to transplant and difficult to nurse even if successfully transplanted. It seems as a mountaineer imprisoned in a dungeon, impatient of its confinement, and rather than live in such conditions, refuses to live at all. The Mayflower, gem of the spring in North America, manifests similar impatience of confinement, and the same is true of several other members of the family.

In Perry county there lingers one of these survivors of our native flora a long battle for its existence against conditions in which no member of its family can long survive. It is struggling against the inroads of cultivation on its native haunts, and struggling against heavy odds.

In the "Flora of North America," Michaux described *Vaccinium brachy*-

cerum or *pumilum*, the box-leaved huckleberry, a low evergreen plant of the Heath Family, giving as its habitat "near Winchester." Its discovery was a testimony to the thoroughness and minuteness of his work in a day when traveling for botanical investigation in North America meant hardship, privation and even danger. The county was unsettled and uninhabited, and the botanist was compelled to wander over pathless mountains, and through forests where the lumberman's axe had never been heard, and to carry with him the results of his labors on his shoulders, or at best on horseback. Yet in some cases he and his fellow-workers lighted on plants to find which again has required long and painstaking search or lucky accident.

Michaux's description and specimen remained for many years the only evidence of the existence of the Box Huckleberry in the world.

About the year 1846, Prof. S. F. Baird, now Secretary of the Smithsonian Institution, was engaged in teaching at Carlisle, Cumberland Co., Pa., when he was informed by a friend living in New Bloomfield (Thomas McIntyre, Esq., recently deceased) that a plant called in the neighborhood "Boxwood," was growing wild near that town. He paid a visit to the place under Mr. McIntyre's guidance, and obtained specimens of the plant both for the herbarium and for cultivation. The latter he sent to the Botanical Garden at Cambridge. This was Michaux's plant, *Vaccinium brachycerum*. Its existence in Pennsylvania had been previously unsuspected, and it was thought to be a lost species. Prof. Gray kindly informs me that those specimens planted in the Garden nearly forty years ago, are still living, and that the plants bloom, but never produce any fruit. Evidently the climate of New England does not suit the species, or it resents the attempt at domestication.

Its Habitat in Perry County.

Vaccinium brachycerum, Michaux, *Gaylussacia brachycera*, Gray, now occupies in Perry county a spot of about ten acres, one mile south of New Bloomfield, the county-seat. This tract lies on a hillside sloping principally to the north-west, and occupied by small timber and laurel. Cultivation has encroached upon it, and so far as I can determine its range was somewhat greater only a few years ago. This is, however, not certain, as Professor Baird does not very clearly recollect how far it spread in 1846. One of the most remarkable facts connected with it is the very sharp line which marks its limit. The wood in which it occurs extends for some distance along the road, but the Box Huckleberry only grows as far as a hollow occupied, in wet weather, by a small stream. Along the right bank of this stream it is found freely, on the left side I have never seen a plant. Hence it is quite possible that the plant has been restricted in its range for a longer time, and that it did not previously occupy the rest of the wood. This is rendered more probable by the fact that in other directions its range is equally restricted, and its limits as sharply defined. It is per-

fectly easy to walk round the space on which it grows, and see a thick mat of it on one side and not a plant on the other. No difference, so far as I can discover, exists to account for this limitation. The soil and subsoil are alike on both sides. Both are timbered, and with the same kind of trees. Slope, exposure, sunshine and drainage are the same. Yet the limitation exists, and is most emphatic.

The most probable conclusion is that we have here a plant to which the conditions of life are becoming or have become unfavorable, and which is very gradually yielding to their ill effects. These have, perhaps, been at work for ages in restricting its range, and would in time have destroyed it. Cultivation, however, is its most formidable foe—a foe which may, in a single season, inflict more injury than natural enemies could accomplish in centuries. Two seasons of ploughing would blot the species out of the county, and, saving the garden specimens at Cambridge, probably out of the world; for Professor Gray informs me that it cannot now be found at the locality given by Michaux in his description, "near Winchester," or at that given on his specimen, "Warm Spring," and, with the exception of one small habitat in Delaware, no other place is known in which it has ever been seen.* One or two other supposed habitats, which have been mentioned to me turned out on examination to be erroneous or doubtful.

In its native dwelling place in Perry county, it is now (May, 1883) in abundant blossom, but judging from the appearance of the fruit of last

* With regard to this habitat for the Box Huckleberry I had not been able to obtain any definite information at the time of writing the above paper. Since then, however, I have been favored by A. Commons, Esq., of Faulkland, New Castle Co., Delaware, with a few particulars concerning it. I give an extract from Mr. Commons's letter:

"The Box-leaved Huckleberry was found by me some years ago growing on the banks of the Indian River, near Millsborough, in Sussex Co., Delaware. I have collected it there at various times but none very recently. Another locality was reported to me when at Millsborough, said to be about a mile from the town in an opposite direction, but I did not visit it. I am not aware of its occurrence elsewhere in this State, and the patch here is not large. The locality is at the head of tidewater on this river. It extends along the steep bank which is here 10 or 12 feet in height from a few feet above the water-line to the top of the bank, but not beyond this. My impression is that it may have been introduced by tidal agency."

A hill-side in Perry Co. and the bank of a tidal river in Delaware, are places affording very different conditions, but Mr. Commons has kindly sent me specimens between which and those from this county I cannot discover the slightest difference.

I may further add that while gathering some of the plants I one day found a small caterpillar feeding on the leaves and spinning them together to form a nest. I put it into a box and it almost immediately went into a chrysalid and in about a month emerged a small Tineid moth with black forewings speckled with white. I sent it to V. T. Chambers, Esq., of Covington, Ky., who has made a special study of this family, and he informs me that it belongs, almost with certainty, to a species described by himself as *Gelechia dubitella*, Chamb., and which has been reported to feed on the Hogweed or Bitterweed, *Ambrosia artemisiifolia*.

year, it does not produce seed very freely. If this is true, one potent cause of its diminution and decay is obvious.

Like some other plants apparently also verging towards extinction, such as the Big Trees of California, this little survivor of the old flora of Pennsylvania shows no disposition to spread in Perry county, even in directions where it is unmolested. Ground lost by such a species cannot well be recovered. Point after point has been ceded to its foes; it has been killed off here and headed back there till now it lingers on this hill-side, its last stronghold in the State, and almost in the world. What special causes have enabled it thus and there to maintain its ground against its foes it is impossible to say, but its position is very precarious. A little more cultivation, a little more ploughing and harrowing, a little more "clearing up" and "burning of brush," by the farmer, unaware of the value of what he was destroying, and the little Box Huckleberry will be numbered with the things that were and are not. Its only chance lies in the steepness and sterility of the hillside, which all botanists must hope will enable it long to maintain the unequal contest against so many dangerous foes. Perry county and Centre township will then continue to boast the possession of a natural botanical garden, containing one of the most interesting vegetable relics on earth.

Appendix.

August, 1883. The fruit of the Box Huckleberry is now ripe, and compared with that of other species is scanty. The berries grow singly and not one plant in ten is productive. They are edible, but lack sweetness, and are hence perhaps less attractive to animals. The blossom in early May was profuse, more so than that of its kindred species. The fruit is of the same size as theirs and is covered with a bloom like that of the low blueberry.

On the Equivalent of the New York Portage, in Perry County, Middle Pennsylvania.

(Read before the American Philosophical Society, September 21, 1883.)

The Cardiola Shale.

About 200 feet above the Fenestella shale, the topmost bed of the 30[illegible] feet of Hamilton Upper shale, which in Perry county is the highest layer in which a Hamilton fauna occurs, is a mass of shale differing in some respects from that above and below it. Though no sharp plane of limitation can be drawn at its base to separate it from the 200 (?) feet of barren black slate which is here the representative of the New York Genesee shale (so far as hitherto determined), yet a good physical distinction between the two is afforded in the field by the bleaching of the latter under the action of the air and light. This is so complete that a bank of weather-

eral material from these (Genesee) beds is quite white, whereas a fresh broken mass is nearly black. The shales of which I am now writing do not manifest any so marked change of color, but retain much more firmly their original black tint. They are very smooth and free from sand, usually dark, but sometimes greenish. They may be distinguished somewhat roughly in the field from the overlying Chemung proper, by the former of these characters and especially by the absence of those even bedded, thin, fine grained, square fracturing beds of sandstone which so distinctively mark the Chemung proper in this region.

The beds below these Cardiola shales, that is the representatives of the Genesee of New York, are remarkably barren, and have thus far yielded me no fossils in Perry county. The lower beds of the Chemung proper have also proved unprofitable ground. But the 200 feet of shale to which I have assigned the above name, though by no means rich in fossils, have nevertheless yielded a few species which enable me with confidence to assign them their place as representatives of the Portage group of New York. Some of these are peculiar to these beds, and must therefore be considered "characteristic" for the district. Chief among them, and almost everywhere present where these beds are exposed, is the small but beautiful lamellibranch figured in the Geology of the Fourth District of New York, by Prof. Hall, under the name of *Avicula speciosa*, now *Cardiola speciosa*. This shell was confined in its range to the Portage group of New York at the time of publication of the Geology of the Fourth District, but is reported in the later volume (vol. v. p. 1) to occur also in the Genesee. In Perry county this species occurs toward the top of the beds that lie between the summit of the Hamilton and the base of the Chemung proper, and there is consequently little precipitancy in referring them to the Portage, a conclusion which is in full accord with the evidence furnished by stratigraphy.

I have not yet succeeded in establishing any wide or general physical plane of demarkation at which the fossils given on the next page cease and the Chemung fauna proper begins. The beds are somewhat barren with the exceptions here noted. But a very convenient local horizon is afforded by a heavy bed of sandstone which occurs about 200 feet above the top of the equivalent of the Genesee slate.

This bed of sandstone does not crop out in many places, but I have found it on the north side of the Buffalo hills on the road running from the old Juniata Furnace, where it forms the bank of the stream, and is thicker and more solid than anywhere else. It is also exposed on the road from Bloomfield to Newport, about a mile from the latter town.

Adopting this view we have, for Perry county, the following section in this part of the column:

	Feet.
Chemung shale and sandstone	..
Portage-Chemung sandstone	20
Cardiola (Portage) shale	200

	Feet.
Genesee shale....	200
Fenestella shale....	15
Tropidoleptus shale....	15
Hamilton Upper (Ochrey) shale....	150
Hamilton Fossil ore and Paracyclas shale....	5
Hamilton sandstone....	

The Cardiola Shale and Portage Beds of Perry County.

List of Fossils.

1. Cardiola speciosa, Hall.
2. Styliola fissurella, Hall
3. Lunulicardium fragile, Hall.
4. Ambocœlia fimbriata, n. s.
5. Strophodonta perplana, v. parva, n. v.
6. Goniatites complanatus ?, Hall.
7. Coleolus acicula, Hall.
8. Poteriocrinus, sp. ?
9. Aulopora tubiformis, Hall.
10. Streptelasma, sp. ?
11. Pleurotomaria ?

Details on the palæontology and descriptions of the new species are deferred for want of time.

The new species *Ambocœlia fimbriata* named in the preceding list very much resembles the kindred species from the Hamilton, *Ambocœlia umbonata* Hall, but differs from it chiefly in being set with small, fine spines in regular concentric rows, a feature of which I have seen no trace in the fossils of this genus from other horizons in the county. The presence of these spines gives the casts of *A. fimbriata* an appearance much like those of *Spirifera fimbriata*, Hall.

Wherever the two beds can be examined in position I have found that those containing *Ambocœlia* lie above those containing *Cardiola*. In most sections only one of these fossils can be obtained, the exposures being usually small. Both are, however, so far as I have observed, strictly limited to this horizon, and consequently either is available for determining it.

The best exposure of the Cardiola shale in Centre township is about two miles S. W. of New Bloomfield opposite the house of Mr. Samuel Brown, and for some distance thence toward the hill (Iron ridge) where a small cut shows the shales containing *Cardiola speciosa* and *Ambocœlia fimbriata* in abundance. Measurement of their thickness is difficult on account of the concealment of their base and the uncertainty of dip which is not uniform in either degree or direction. Considerably more than 100 feet is exposed, and towards the upper part of the section the typical Chemung sandstones begin to appear among the shales. The Genesee slate is entirely con-

cealed, unless its topmost layers yield the loose material shown in the roadside cut nearly opposite Mr. Brown's house. This part of the section has yielded no fossils.

The Cardiola shale also appears in the side of the road leading to Perry Furnace near the house of Mr. Quigley. It is here a very smooth, yellow green shale, and has yielded

Cardiola speciosa.
Strophodonta perplana v. parva.
Ambocœlia fimbriata.
Styliola fissurella.
Goniatites complanatus?

A third exposure of these beds is at the mouth of Losh's run, in Wheatfield township, where, in a cut on the roadside, the lower or Cardiola beds may be seen and their fossils collected. I have obtained here,

Cardiola speciosa.
Strophodonta perplana v. parva.

A fourth exposure of these Portage beds is on the south branch of Losh's run, about two miles west of the Juniata and near the cross-roads, at the house of Mr. D. Bosdorf. Here the upper beds only occur, yielding

Ambocœlia fimbriata.
Strophodonta perplana v. parva.

A fifth exposure of these shales is on the road leading south from Newport to the ore works on Limestone ridge, near Pine grove. Near the house of Mr. J. Ramer occur dark smooth shales by the road yielding

Styliola fissurella.
Cardiola speciosa.
Coleolus acicula.

A sixth exposure of the same shales occurs near Newport, on the upper road to Baileysburg, soon after leaving the river. Here the Portage-Chemung sandstone is cut twice at a bend in the road, and close underneath it come the shales yielding the usual fossils. Only a few feet of the highest part of the Portage are exposed, but the following species were found after a short search:

Cardiola speciosa.
Ambocœlia fimbriata.
Styliola fissurella.
Aulopora tubiformis.
Strophodonta perplana v. parva.

This exposure has also yielded me a small crinoid *Poteriocrinus*, apparently undescribed, and a *Streptelasma*, both of which I have been unable for want of time to examine minutely.

I have little doubt that the fauna of this Portage group might be much increased by longer search. One or two additional species have been already obtained by recent visits to some of the other places mentioned above.

The following extract from the Geology of the Fourth District of New York will show the close resemblance between the rocks at the two places: "The thick-bedded sandstones at Portage form the terminal rocks of the group." "The upper part consists of thick-bedded sandstone." "The arenaceous strata of the Portage group are always more argillaceous than those of the Chemung group."

It appears from Prof. Hall's description of the group that it begins with beds very free from sand—the Cashaqua shale—and ends with a heavy thick-bedded sandstone. At least this is its character at its eastward exposures on the Genesee river. Farther west the sand, as usual, disappears and the group contains little except shale.

The Portage group in Perry county comes, therefore, as near to the typical Portage group in New York, as can be expected—near enough in stratigraphical and palæontological characters to give full confidence in their identification.

I may add, in conclusion, that some of the shale beds near the Portage-Chemung sandstone are much valued locally as whetstones. These apparently occur both above and below the sandstone.

In one place also, a bed of light-colored brown hematite has been exposed lying on the top of the sandstone and about eighteen inches thick. This is the only case of the occurrence of a bed of iron ore of any appreciable thickness in the Chemung of Perry county. No trial has yet been made of it, but judging from appearance it would not be of high grade.

The facts given above are useful in that they enable us to separate 400 feet from the great mass of olive shale in Perry county. The separation of 200 feet, as the Hamilton Upper shale, was mentioned in the beginning of this article. The total thickness of the olive shales of VIII has been given in the neighborhood of Newport, at about 5500 feet, thus divided:

Chemung	3800
Portage	600 about.
Genesee	1120
	5520

But these measurements are much exaggerated. They have apparently been made along the Juniata, without noticing a fold which occurs at Inoculate run, and the effect of which extends beyond the river. The ground is very difficult, but the following figures, which I have obtained with considerable trouble and checked as carefully as was possible with the limited time at my command, are certainly nearer the truth for the neighborhood of Newport:

Chemung	3000
Portage	200
Genesee	200
	3400

It thus appears that after the separation of the 600 feet above mentioned,

the thickness of which is only approximately given here, there yet remains an immense mass, the subdivision of which is more difficult, but would not perhaps be impossible if sufficient time were allowed.

I am unable as yet to say if these Cardiola shales extend far north and south, no exposures having been yet found. But the places above mentioned trace them through the middle of the county from south-west to north-east, a distance of seven or eight miles. Their farther extension is very little less than certain.

Appendix.

Since the above paper was read I have spent a few hours with Prof. I. C. White, now engaged in the survey of Huntingdon county. With his assistance I found the bed here described and most of its fossils near Huntingdon. The thickness, though shortness of time prevented measurement, seems also very nearly the same.

Note on the Genus Rensselaeria in the Hamilton Group in Perry Co. By E. W. Claypole.

(Read before the American Philosophical Society, September 21, 1883.)

The Genus Rensselaeria, Hall, was established to receive certain Brachiopods, some of which were new, and others of which had previously been known under other names. They were distinguished by their general outward form and certain peculiarities of internal structure from other Brachiopods nearly allied to them.

The Genus Rensselaeria is limited in Eastern North America to the Lower Helderberg and Oriskany groups, four of its twelve species occurring in the former and seven in the latter. One only, a small species, *R. Johanni*, Hall, has been described from the Upper Helderberg of Waterloo, Iowa. Of this Prof. Hall speaks doubtfully, referring it to this genus only on account of its external characters.

Prof. Hall informs me that he has since that time removed this species from the genus. It is, therefore, rather surprising to find well-marked specimens of Rensselaeria high up in the Hamilton group of Middle Pennsylvania. Yet the sandstone, so conspicuous a feature of this group in Perry and adjoining counties, yields, near its middle, a bed which is in some places little more than a mass of shells of a form which can scarcely, if at all, be distinguished from *R. Marylandica* of the Oriskany sandstone.

In some places this shell is found almost alone, but in others it occurs mixed with *Spirifera formosa*, or a species so like it that I cannot distinguish them. This Spirifera is the most abundant fossil in the Hamilton sandstone of the county, occurring sometimes in myriads.

The Hamilton sandstone is a peculiar deposit of sand in the midst of a vast accumulation of shales. It covers a district extending from the Blue mountain northward for about fifty miles and eastward to the neighborhood of the Schuylkill river. Westward its limit cannot be traced, as it is destroyed by erosion, but from appearances it was as great as in the east. It lies between a mass of shale above and another mass below, and at its greatest development is about 800 feet thick, at the Susquehanna gap. Some of its beds, especially toward the middle, are very hard and flinty, but it grows more and more shaly as it recedes from this point. Apparently it exists at some distance from its point of greatest development as a sandstone mass below and another above, with intervening shales.

Note on a large Crustacean from the Catskill Group of Pennsylvania. By E. W. Claypole.

(Read before the American Philosophical Society, Sept. 21, 1883.)

I have lately received from Mr. R. D. Lacoe, of Pittston, a slab of green sandstone, from the Catskill group of Wyoming county, containing a well-preserved head of some creature. Though not complete, yet enough remains to enable me to form a good idea of what the full form of the head must have been.

It measures eight and a half inches across the broadest part, and the same from front to back. The outline is semi-elliptical, the part preserved corresponding to a piece cut from one of the ends of an ellipse. It is somewhat distorted, and may when perfect have been more nearly semicircular. The outline is slightly wavy, but this also may be due to distortion. Fortunately the right side is almost perfect and, being symmetrical, it is not difficult to reconstruct the other. A good idea of its general shape may be suggested to a palæontologist by saying that it resembles the head of *Cephalaspis*.

A longitudinal median ridge runs from near the front margin almost to the back of the portion preserved, dividing the head surface into two equal parts. This ridge rose near its front end into a low tubercle, or perhaps a spine, and near its hinder end into a distinct and boldly elevated spine which is, however, crushed down almost flat. Posteriorly the ridge narrows and tapers down to the general surface.

At the place of the posterior spine another ridge, less distinct, crosses the former at right-angles, and itself rises at its two ends, midway to the outer margin, into low prominences from which two semicircular ridges, convex outwardly, run curving in toward the median line at both their ends, one in front, the other behind the cross-ridge from which they start. Each cross-ridge, with its semicircular branch, resembles in outline an

Proceedings of the Amer. Philos. Soc. Phila. Sept. 21, 1883. Vol. XXI. Page 236.

Scale of Inches.

Dolichocephala Lacoana, Claypole, from the Catskill rocks of Wyoming county, Pennsylvania.

anchor-shank with its two arms. Right and left of the anterior tubercle, and not quite half way between them and the margin, arise two broad, rounded prominences anteriorly, elongated and connected with the median ridge by a scarcely perceptible elevated tract.

The whole surface of the head is covered with small wrinkles or tubercles, the former chiefly in front, the latter behind, and the margin is marked by a narrow groove about one-eighth of an inch in breadth, resembling that which often marks the head of a trilobite.

No trace of bone can be found upon the specimen, so that there is no ground for supposing that it is the head of a fish. But the greater part of the surface is covered with a thin, black, perhaps carbonaceous, coating, highly suggestive of the carapace of a crustacean. This is, beyond doubt, its nature, and the fossil represents a large species hitherto unknown, and from an horizon which has thus far yielded nothing similar to it. The only crustaceans yet announced from the Catskill are some small entomostracans mentioned by the writer at the meeting of the American Association at Montreal. The specimen in question possesses therefore an unusual interest.

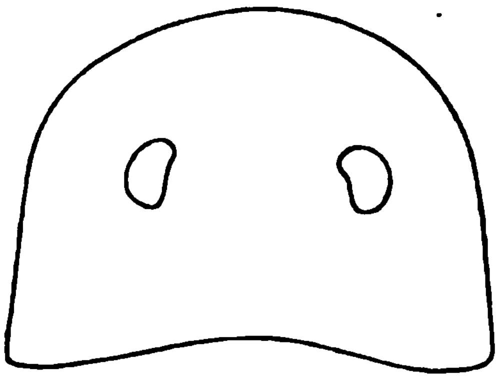
From so small a portion of the specimen it is difficult to assign it its exact place in the animal scale, but among the crustaceans we are led immediately to look at the allies of the existing king-crab, *Limulus*, and those of the fossil *Eurypterus* and *Pterygotus*. Both of these possess the peculiar trilobitic head-shield, and may, therefore, supply useful information concerning this species.

But the general outline of the fossil being semi-elliptical, does not well agree with that of *Limulus*, and its fossil allies, which is semicircular. Limuloid forms descend to us from Silurian days, but they all present a semicircular head-shield similar to that of the living king-crab, *Limulus Polyphemus*, or *Moluccanus*, of the east coast of America, and the Molucca islands. The same form of head-shield characterizes all the fossil genera allied to *Limulus*—*Hemiaspis*, *Bunodes*, *Euproops*, *Belinurus*, and *Halycine*. It is, consequently, impossible to refer our specimen to the dagger-tailed family of *Xyphosurans*.

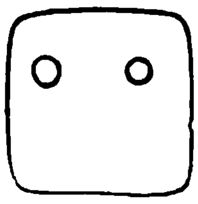
Not better does the outline of the head agree with that of the rounded, oblong head-shield of Pterygotus and Eurypterus. Yet, in some respects, it reminds us of these. But the discrepancy is too great to allow of its reference to any established genus of the Eurypterids. This will be evident on an examination of the accompanying outlines.

The eyes being undiscoverable in the fossil, the important evidence which they might afford towards settling its relationship is not available, but very important and conclusive testimony is derived from the markings on the surface of the carapace. Beside the wrinkles or tubercles mentioned above, the crest is covered with small, delicate, crescentiform sculpture, resembling that which is characteristic of the Eurypterids, and a representation of which is given in the plate.

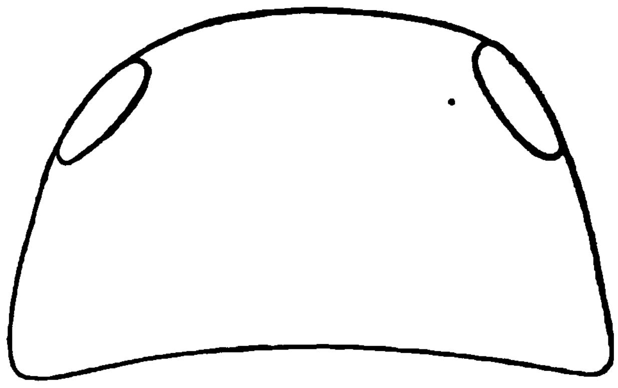
Considering all these facts I have determined to place the fossil in a new genus established to receive it, and named from the elongated head *Dolichocephala.* The generic and specific descriptions are necessarily imperfect, being founded on imperfect specimens, but the characters of the head are distinct.



a.



b.



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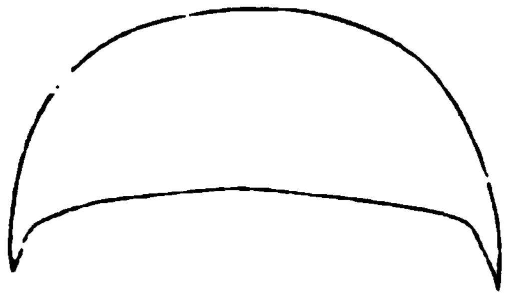

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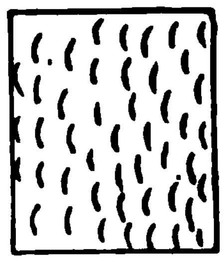


e.

a. Eurypterus remipes,
b. Stylonurus Logani.
c. Pterygotus Anglicus.
d. Limulus rotundatus.
e. Scale-like sculpture of *Dolichocephala,* nat. size.

DOLICHOCEPHALA, n. g.

Genus of Crustaceans allied to Eurypterus. Head-shield only known. General outline semi-elliptical (the length being parallel to the major axis of the ellipse). Surface slightly convex; margin furrowed. Medial line marked with an elevated ridge, beginning near the front, and rising into spines or tubercles at different points along its course, sinking again to the general level posteriorly. Another obscure and interrupted ridge or row of tubercles lies between the median ridge and the margin, and another, more or less defined, crosses the median ridge at right angles near its hinder extremity.

Whole surface marked with small, low tubercles, and, beside these, with minute delicate scale-like sculpture.

DOLICHOCEPHALA LACOANA, n. s.

General outline as in genus; margin with two narrow furrows and a fillet between them, the whole almost a half an inch wide. Median ridge

well marked, rising anteriorly in a low spine or tubercle, and again in a larger or more prominent one at its hinder end. A lower ridge crosses this at right angles, extending about half-way to the margin, and at the end of this are two semicircular ridges curving inward half-way to the median ridge, and sinking to the general level. In the hinder angle, between this and the cross ridge, is a roundish mark which may indicate the place of the eye. Another elongated tubercle or short ridge lies between the anterior end of the median line and the margin.

Surface marked with crowded, low tubercles, and with the delicate, scale-like sculpture of the genus.

The fossil was found in the sandstone of the Catskill group at Meshoppen, Penna., and is the property of R. D. Lacoe, Esq., of Pittston, to whose kindness I am indebted for the use of the specimen, and in whose honor I have named it.

There is a species of Eurypterus described by Prof. Whitfield, in the forthcoming volume of the Palæontology of Ohio (New fossils from Ohio. Pamphlet), of which he says:

"The cephalic shield is proportionately broader than that of *E. remipes* or *E. lacustris*, and is more regularly rounded or arched on the anterior border, lacking that subquadrate form characteristic of those species."

This species, *Eurypterus Eriensis*, from the hydraulic limestone of Put-in-Bay, Ohio, shows a manifest departure from the ordinary type of the head of Eurypterus, but the variation seems rather in the direction of *Limulus* or *Euproops*, than in that of *Dolicocephala*. As Prof. W. does not mention the size of his specimen, it is impossible to say how nearly the two approach in that respect. The horizon from which it comes in Ohio is the equivalent of the waterlime of New York, to which the genus Eurypterus is almost entirely confined. Two species are described from the Coal Measures, and one from the Devonian, of Pennsylvania.

Stated Meeting, October 5, 1883.

Present, 10 members.

A photograph of Professor James Morgan Hart was presented for insertion in the Album.

Letters of acknowledgment were received from the Smithsonian Institution (113), and the Sociedad Economica de Valencia, September 16.

A letter of envoy from the Department of the Interior was read.

Donations for the Library were reported from the Annales des Mines, Revue Politique, Commercial Geographical Society at Bordeaux, Meteorological Committee and London Nature, Essex Institute, Boston Natural History Society, American Journal of Science, New Jersey Historical Society, Franklin Institute, American Medical Association, Journal of Pharmacy, H. Phillips, Jr., United States Fish Commission, Surgeon-General's Office and United States Geological Survey.

An obituary notice of the late Henry Seybert was read by Mr. Moncure Robinson.

The death of Prof. J. Reinhard Blum at Heidelberg, August 22, aged 80, was reported.

The death of Prof. W. A. Norton at New Haven, Connecticut, September 21, aged 72, was reported.

"The Zone of Asteroids and the Ring of Saturn," by Prof. Daniel Kirkwood, of Bloomington, Indiana, was read by the Secretary.

Prof. Barker brought to the attention of the Society a number of electrical novelties: small batteries which can be sealed up and applied to special practical purposes, such as lighting gas lamps, treating nervously diseased patients, ringing an alarm bell when the heat of a room becomes unduly raised, &c., and a new and much cheaper method of coiling and insulating wire, by winding the naked wire and a cotton thread together on the same spool. These inventions of Mr. Clarke of Manchester, were exhibited and explained.

Pending nominations Nos. 985 to 1006 were read.

And the meeting was adjourned.

OBITUARY NOTICE OF HENRY SEYBERT.

BY MONCURE ROBINSON.

(*Read before the American Philosophical Society, October 5, 1883.*)

MR. PRESIDENT AND GENTLEMEN:

I have occasionally, when asked to write an obituary notice of a departed friend, felt, as a prominent citizen in the earlier days of our Republic is said to have replied, when asked if he would accept a nomination to the Presidency, "The office" (his reply was) "is one not to be sought or declined." The eminent and virtuous citizen who, sixty years ago, made this reply, made it in view of the immense responsibility of the office. But, Mr. President, more or less responsibility attaches to the performance of all the duties of life, and the writer of a brief sketch of the life of a departed fellow-citizen, for the information of the public, is obliged to recollect the motto "*de mortuis nil nisi verum*," as well as that "*de mortuis nil nisi bonum.*" None of us, sir, are infallible, or free from the frailties which pertain to our humanity, and we should act tenderly and affectionately, as well as truly, in dealing with either frailties or mistakes, especially when, as in the case of our departed friend, they were only *peculiarities* not amounting to a fracture, or a flaw, or even a blemish, in the escutcheon of a life of blended usefulness and goodness.

The friend, Mr. Seybert, of whom you have re-

quested me to write an obituary notice, was at the time of his death the oldest member of our Society; one who at an earlier period in the annals of societies would have borne the title of *its Dean*. He was elected one of its members January the 16th, 1824, three weeks only after the twenty-second anniversary of his birth, at a period when the Society had on its list of members as many distinguished and learned men as at any period before, or since, when (as I presume is still the case), new members were nominated and elected without the slightest previous knowledge of their nomination being proposed, and when in the case of rejected nominations, no one besides those present knew that their names had been presented for consideration. On the 5th of March, 1824, between six or seven weeks after his election, Mr. Seybert read to the Society a clearly written and most interesting analysis of the chrysoberyls of Haddam (Connecticut), and Brazil, a mineral and gem next to the sapphire in hardness, and which had for some years previous attracted much attention on account of its rareness, rather than its value. This inaugural discourse of Mr. Seybert will be found in Volume 2d, Article No. 3, of the new series of transactions of the Society, page 117.

It is proper before proceeding farther, to tell you something of the parentage and early training of Mr. Seybert, which will explain how he became a member of our association at an earlier age than any member

who preceded or succeeded him, since its foundation to this day.

His father, Adam Seybert, was a Philadelphian by birth and education, and distinguished as a chemist and mineralogist, who represented his native city in Congress during eight successive years, three of them (the years 1812, '13 and '14), years of great trial, and at the time characterized as the period of our country's second war of independence. Between the close of this war and 1818 Mr. Seybert found time to prepare and give to the world, whilst performing faithfully his duties as a member of Congress, and in his laboratory, his "*Statistical Annals of the United States of America*," a work reviewed in the Edinburgh Review of January, 1820, by the Rev. Sydney Smith, in an article which speaks of it as "a book of character and authority," "which will form a pretty complete portrait of America, and teach us here to appreciate the country, either as a powerful enemy or a profitable friend."

As a chemist and mineralogist he is spoken of in a work by Professor Benjamin Silliman, of Yale College, entitled "American Contributions to Chemistry," page 36, as follows:

"Adam Seybert is one of the few American chemists who enjoyed the advantages, rare at that time, of a training in the School of Mines at Paris, late in the last century. He has left few papers, but his memoir, read before the American Philosophical Society, March 10, 1797, entitled, 'Experiments and Observations on

Land and Sea Air,' is of interest, as the earliest example of such a research on our records. It relates the results of twenty-seven analyses of air made by the author at sea, in a voyage across the Atlantic, and also the comparison of these results with other analyses made by him on land, near Philadelphia, by which comparison he reaches the conclusion that the air over the sea is purer than that over the land; that, while the latter varies with locality, the former is nearly constant; and he then ventures the suggestion that 'perhaps the impurities are absorbed by the agitation of the waves,' a conclusion to which modern investigation, by the use of more exact methods, has also arrived. Considering the imperfect condition of eudiometric methods in Seybert's time, his research and conclusions therefrom are decidedly creditable to his skill and sagacity."

The mother of Henry Seybert was Maria Sarah, daughter of Henry Pepper, Esq., of Philadelphia, one of its wealthy and respected citizens. Mrs. Seybert died during the early infancy of her son, and the care of him in infancy, and responsibility of his whole educational training, thereby devolved exclusively on his father, who remained a widower until his death, in Paris, on the 2d of May, 1825.

I met there a few days after the death of his father, Mr. Henry Seybert, who had accompanied him to Paris, and been there his constant companion and solace, during the critical disease which ended his

father's patriotic and useful life, at the comparatively early age of fifty-two years. He was in deep mourning, and, being naturally reserved, had but few acquaintances among his countrymen in Paris, themselves then comparatively few in number. Being within a few weeks of the same age with him, and sincerely sympathizing with him in his profound sorrow, we became, naturally, in a short time well acquainted. This acquaintance ripened, during our travels together in England the following summer, into a respect and friendship which continued uninterrupted, until we were separated by his death on the 3d of March last.

At that time, and indeed until recently, I knew but little of the honorable and valuable life which Mr. Henry Seybert had been leading for several years previous in his native city. His disposition was taciturn, and he preferred generally listening to the opinions and conversation of others to taking part in conversation himself, and but for the request of the Society to prepare this tribute to his memory, I should probably never have known how highly he was estimated at the time of our first meeting, by eminent chemists and mineralogists, of both Europe and America. Professor Benjamin Silliman, in the volume before quoted from, in which he speaks of Mr. Adam Seybert, makes the following mention in page 74, of the same, of the son:

"Like his father, Adam Seybert, he was educated in the School of Mines in Paris, and was an early contributor to our knowledge of the constitution of Ameri-

can minerals. In 1882 he analyzed the sulphuret of molybdenum from Chester, Pa.; chromate of iron from Maryland and Pennsylvania; the tabular spar pyroxene, and colophonite, of Willsborough, N. Y., and the Maclurite (chondrodite) of New Jersey (in which he independently discovered fluorine as Dr. Lanstaff had done before). He also analyzed the manganesian garnet, found with the cheisoberyl at Haddam, Conn., and the chrysoberyl of the same locality. In 1830 he analyzed the Tennessee meteorite of Bowen, since which date I have been unable to find any further contributions from Mr. Seybert, whose attention was unfortunately diverted from science, to which his early life was so advantageously devoted, to other and less fruitful lines of investigation."

It is to be regretted that Professor Silliman knew but little of the occupations of Mr. Seybert after the death of his father in the spring of 1825. Being the only living descendant of his father and mother, he inherited a large fortune, and it is certainly not singular, that a young gentleman of twenty-three years of age, who had inherited a fortune estimated by his contemporaries at $300,000, who had been occupied closely for several years in the laboratory, in chemical and mineralogical investigations, which had made him an honored member of our body, and given him a name and reputation among the scientists of Europe, at the early age of twenty-two, but who had at that time seen nothing of the great world, should have

been tempted to give up for some years, to a great extent, the laboratory, for the pleasures of society and travel. To this, is no doubt ascribable the fact that after May, 1825, the period of his father's death, Professor Silliman was unable to find "any further contributions from Mr. Seybert," besides the analysis of the Tennessee meteorite of Bowen in 1830.

It has been suggested that the last sentence above quoted from the discourse of Professor Silliman, had reference to his spiritualistic investigations. If so, Professor Silliman labored under a great mistake as to Mr. Seybert's occupations between 1830 and 1850. During all that period he was certainly much more of *a Materialist than a Spiritualist*, but I think more of *a Christian,* though for a time a doubting one, than either. But notwithstanding his religious doubts, and perplexities, he gave, during that period, both in this country and Europe, where he passed much of it, his attention and aid to works of charity, and valuable enterprises. Among the latter I recollect his perfect confidence, speedily verified, notwithstanding the decided opinions and predictions of Lardner and others to the contrary, in the general adoption, within a brief period, of steamships between America and Europe.

It may indeed be doubted whether the large accession of fortune to Mr. Seybert, on the death of his father, was a fortunate feature in his history, and it very probably was not. Had it been less, he would probably have continued a co-laborer with his friends in

Europe and the United States, in his previous employments, and his reputation as a chemist and mineralogist, would probably have increased in a corresponding ratio with theirs. But it may fairly be inferred from what we now know of his traits of character, that he was one of those who believed in doing their duty in that state of life in which it pleases the Almighty to place them, and if so, he naturally inferred that duty in his own case, was materially modified by the possession of a large fortune, which, properly employed, might enable him to be more widely useful to his fellow-citizens and fellow-men, than he could be even if enrolled with the Elie de Beaumonts of Europe or the most distinguished chemists and mineralogists of America.

The change in the views of Mr. Seybert as to the life most proper for him in the future, was probably adopted soon after the death of his father, and a few weeks previous to his visit to England, in the summer of 1825, referred to in a previous page. We had the good fortune to have as traveling companions in this visit, that pure and excellent man and Christian gentleman, Mr. Nathaniel Chauncey, of Philadelphia, and Mr. Jaquelin Ambler, of Virginia, a member of one of the old and honored families of that State, in its better days.

We harmonized wonderfully in our views as to the places and objects to be visited by us; our scientist, Mr. Seybert, preferring, like the rest of us, a view of

the magnificent residences, and beautiful parks, and venerable Gothic temples of the past, with a brief stay in her manufacturing and commercial cities, to any other disposition of the time at our disposal. We found, in short, our companionship in England so agreeable, that we sought to continue it on our return to Paris by dining frequently together at the same restaurants, and table d'hotes, and passing our evenings at the same theatres, especially the Theatre Français, which, in the winter of 1825 and '26, still numbered Talma and Mars among its attractions. But there was one place in Paris especially attractive to *our partie carrée.* This was the residence of Madame de L., who had been unfortunate in her marriage, but was blessed with a lovely and beautiful little daughter, at the time only five or six years old, who was the pet of all of us. The husband of her mother, though well connected, was extravagant and wasteful in his habits, and had expended not only his own fortune, but a large part of that of his wife, thus creating the necessity of her receiving table boarders, and occupants of rooms, in order to secure the accustomed comforts to herself and daughter. Mr. de L. was occasionally, but not often, one of her guests.

Their daughter, who still retains a great deal of her own and her mother's grace and beauty, sent to myself, as well as Mr. Seybert, two or three years ago, an admirably executed photograph of herself, with a request, which I promptly complied with, that we would

send her ours. But my excellent though modest friend, Mr. Seybert, would not be persuaded that the wish expressed by her, was anything more than a compliment, and I do not think, at the time of his death, that he had sent his. I was truly gratified to find from his will, that though the compliment paid us was not responded to by him, Mr. Seybert did not doubt her warm and affectionate regard.

I ought here to say on what this regard was founded. It was the result of one of those incidents or accidents of life which cause us to realize that "truth is sometimes and not unfrequently stranger than fiction." The fact of Messieurs Chauncey, Seybert, Ambler, and myself dining together at the apartments of Madame de L. made us all feel a strong interest both in Madame de L. and her lovely little daughter. Mr. Seybert remained in Europe for a year or more after the return home of his fellow-travelers, and afterwards divided his time for many years between Europe and the United States, and thus had the opportunity, which they had not, of witnessing the development, in form and feature, as well as in intellect and beautiful nature, of the gifted daughter of Madame de L., and profited of the opportunity to offer to Madame de L. the advance of any funds she might require during the important period between girlhood and womanhood, to procure for her daughter the best instructors in languages and music, and such other accomplishments as she might deem appropriate and desirable for her.

A few years later, when Madame de L. found it necessary to obtain what is termed in France a divorce "*de corps et de biens*" from her husband, in order to protect a small remainder of her property, Mr. Seybert, believing in her ability to manage a large Hotel Garni, well and profitably, advanced to her the means of leasing and furnishing one, advantageously situated on the Rue Castiglione. The enterprise was so successful that, in an unusually brief period, Madame de L. was enabled to return to Mr. Seybert his advances, and leave for herself a modest but sufficient property for her support in her declining years.

It has been forty or more years since these services were rendered by Mr. Seybert, and Mlle. de L. had become within that period the wife of an honorable and respected citizen of Paris, and the mother of attractive and accomplished daughters worthy of their descent. But the services rendered by Mr. Seybert to her mother, now no more, and herself, will never be forgotten by the lovely and accomplished daughter, Madame de Saivre, who was for many years a constant and regular correspondent of Mr. Seybert, and whose affectionate and grateful remembrance was remarkably evinced, during and since, the illness which preceded his death.

Not hearing from him for a longer period than usual, she feared he might be ill, and wrote me asking me to inform her if he was seriously, or dangerously so. In compliance with her request, I gave her several times

information of him during his illness, writing on each occasion as encouragingly as I could, in view of her evident solicitude. When requested by you to write an obituary notice of Mr. Seybert, I thought it probable she could give me, in regard to his views on many subjects, information of interest to his American friends, and expressed in a letter to her the hope that it would be agreeable to her to do so. In reply, I received, in the month of June last, a letter from Madame de Saivre, from which I have copied and translated into English the following extract. It is impossible, I think, to read it carefully without coming to the conclusion that the course of action of Mr. Seybert, during the last half of his life, is most correctly and satisfactorily explained by it.

" During the long period (says Madame de Saivre)
" of our acquaintance in France, he occupied himself,
" at first, a good deal in reading scientific works, and
" attending lectures on History and Chemistry, but it
" seemed to me even then that his principal vocation
" was in doing good. He aided the unfortunate and
" improvident in their efforts to recover themselves
" and lead an honorable existence, and in order to e
" rich himself to promote this object, I know esta-
" lished several persons in America; often, also, I ha
" known that he was not repaid money advanced
" him to persons who had profited of his confiden
" and credulity, but were not in haste to repay t

"money borrowed by them. Nevertheless he did not "weary in being charitable.

"Years ago Mr. Seybert spoke often to me of his "studies in Spiritualism, and of a great mission with "which he was charged here below. I confess I did "not at the time divine what the mission might be. I "asked myself only whether *mediums*, more or less "sincere, were not abusing his confidence, in order to "guide him, after their fashion, in their interests. "Though I made many inquiries, Mr. Seybert never "explained himself *clearly* on the subject *of this mis-* "*sion.* But now, aided by the knowledge of his last "will, I think I understand that beautiful mission which "he has made the object of his life, and can inform "you what has given rise to it.

"I recollect hearing Mr. Seybert say (I was then "about sixteen years old), that he was discouraged and "saddened, that he was studying uselessly, and seeking "vainly the shortest and surest way to save his soul, "which, in spite of his efforts, he could not see clearly. "He had read in the Holy Scriptures that a rich man "could no more enter Paradise than a camel could "pass through the eye of a needle, and he was tor- "mented with the thought that all his attempts to lead "a good life were useless, as regarded a future life, "*because he was rich.* Our poor friend was really very "unhappy, and, I recollect, sought conference with our "eminent religious men and casuists, and went even "to Rouen to see the Prince de Croy, the Archbishop,

" on the subject. They all assured him, that this sen-
" tence was addressed to the *sinful* rich *only*, and not
" to those who gave of their goods liberally to the
" poor. In fine, they affirmed to him that *a really good*
" *rich man* should *fructify* his property, with the object
" of distributing it among the poor, and needy, and
" that on this condition only, could he be sure of reach-
" ing the Almighty after his death. From this mo-
" ment, dear sir, the vocation of our friend has been
" fixed. He has lived modestly, even economically,
" having reference to his large fortune, in order to ful-
" fill here below the Christian mission of the good rich
" man; that is to say, he has *fructified* (increased) the
" estate which God had confided to him, in order to
" be able to bestow more on those who suffer! Is not
" this exemplary and magnificent? May we not feel
" assured that God has already rewarded our friend?
" As regards myself, I am persuaded that he was drawn
" into his studies of Spiritualism, by the hope of finding
" in it some day the assurance that he was in the best
" of ways—that of charity."

We see in the above extract why Mr. Seybert exercised so close an economy in his personal expenses, and reserved his large benefactions until his death. Why he bequeathed so small a proportion of his fortune to his relations and attached friends, most of whom were in easy circumstances, knew his views, and expected nothing from him, and others who, like Mad-

ame de Saivre, knew and approved them, and would not have desired them to be changed.

Few men certainly have lived of more expanded benevolence, but he was especially devoted to the reputation and welfare of his native city, and his views were well defined as to what should be done by him from a sense of duty as a citizen, and to relieve want and suffering.

Many of our older citizens probably recollect that thirty or forty years ago he gave his time and expended large sums of money, in endeavoring to substitute extensively in Philadelphia, soda and other mineral waters at low prices, for alcoholic drinks. At a later period he improved, at considerable cost to himself and with much personal trouble, the *bread* of the city, and within the last eight years he gave to Philadelphia "a magnificent clock and bell, for which, at a special meeting of the Select and Common Councils of the City," on the 10th of July, 1876, the thanks of the city were tendered him. This clock and bell as yet, it is believed, unsurpassed by anything yet executed for a like object in our country, have been doing good service night and day since, "from the tower of Independence Hall," to a large proportion if not to all the inhabitants of our extended city.

The above services of Mr. Seybert to his fellow-citizens could not have been "done in a corner," and were *necessarily* known to many of them, but those who were acquainted with Mr. Seybert knew that his

object in rendering such services was *not to be talked about*, but *to be useful*. His acts of charity to individuals, manifold more numerous, were known only to their recipients and those whose co-operation was necessary to their being carried out. He was faithful all his life as far as possible to the injuction of our Saviour, in His sermon on the Mount, "Let not thy left hand know what thy right hand doeth."

In the commencement of this discourse, I alluded to traits of character in Mr. Seybert which I termed "peculiarities," but most of which might more properly be termed *exaggerated ideas of duty*. To one of these Madame de Saivre alludes in the extract read by me from her letter, in which she refers to the economical habits of Mr. Seybert, with the object of increasing the amount he purposed giving to the poor at his death. We may, I think, reasonably believe that the Almighty could not have intended that the liberal man, who gives liberally of his goods during his lifetime to the unfortunate and needy, should also economize closely in expenditures probably essential to his health and comfort in order to add to the large amount he designs giving at his death. The opposite of this I cite as one of the peculiarities of this most estimable gentleman. Another equally remarkable and equally creditable has attracted my attention in reading his will; this is *naming* the endowments authorized in the will after one or both of his parents. No one can respect more than the writer of this obitu-

ary notice does, the feeling of reverence and affection which dictated this direction; but his mother had died in his earliest infancy, eighty-one years ago, and his father fifty-eight years ago, and he, himself, was an aged man.

He could, therefore, not reasonably have been supposed wanting in respect and reverence for his parents in letting the endowments bear *his own name* instead of theirs, but the memories of his youth and the *fifth* commandment, "Honor thy father and thy mother that thy days may be long upon the land which the Lord thy God giveth thee," seem to have been always primary and paramount considerations with him.

Madame de Stael in one of her works, but which of them I cannot at the moment recall, expresses herself as having no *veneration* for any being in the universe but God and her father. Mr. Seybert has been for many years a sincere believer in the Christian religion, and of course could have used no language as little reverential to the Almighty, as that of Madame de Stael, but he has appeared to me to have had, ever since I have known him, a sincere veneration (which he would have been unnatural not to have had) for his father; for though that father was what the world would now perhaps call a *hard* father, Mr. Adam Seybert was so in consequence of his profound affection for his son, whom he desired to make at least his equal and if practicable his superior in the sciences of chemistry and mineralogy, to his knowledge of which he was mainly

indebted, at a comparatively early period of life, for both reputation and fortune, and the importance of which, in the future to his country and the world, he fully appreciated.

In speaking of Mr. Seybert's will I am reminded of his delay and difficulty in determining its provisions. This was the result of what he believed to be information from on high; that though he had long since passed the three score and ten years allotted to man, enough more years would be allowed him to enable him to witness great moral changes in the world, and the commencement of the "Heavenly Kingdom on earth." The excellent health he had for many years enjoyed, due to his regular habits and even temper, naturally aided in encouraging this idea, and but for a protracted illness growing out of a very slight cause, he would probably have postponed indefinitely signing and executing a will, which, in such a contingency, he would probably have deemed superfluous and perhaps undesirable.

The slight cause alluded to, was his wearing for the first time, about three years ago, at a dinner party in the country, some twenty miles from Philadelphia, a pair of boots not before used, the pressure of one of which for six or eight hours (the day being warm) upon a bunion on one of his feet, produced a serious swelling ending in inflammation of the whole foot and its suppuration, by which he was confined to his house and bedroom for many months; preventing, during

that period, his usual exercise in walking and driving, and causing thereby a corresponding diminution of appetite and strength. This great change produced, naturally, doubts in his mind as to his previous anticipations of his life being much longer extended, notwithstanding the assurances of the Spiritualistic mediums consulted by him, and a gradual though slow improvement in his health and appetite during the spring and summer of 1882, by visits to the Saratoga and Richfield Springs and the Coney Island baths, near New York, and these doubts caused him to consider and act on the presumption that he and those who looked to his life being prolonged were probably mistaken, and the early and close consideration by him of such a will as would carry out as nearly as practicable his views.

He had frequently in previous years, asked my opinion as to what I would do *in his place*, and with his views; that is to say, if I were unmarried and had no children and my near relations were all in easy circumstances. I had always replied to the inquiry that I knew of no charity which, in my opinion, would be so beneficent and valuable to Philadelphia as an institution having from the Legislature paternal powers to take up little boys and girls, neglected or abandoned by their parents, and who were crowding our streets either openly as beggars, or in the guise of "Newspaper boys," or on other pretexts, and who would necessarily grow up unfitted for any useful occupation;

but who, if under the care and control of a benevolent association, duly authorized to apprentice them to proper parties at the proper times, would be fitted for lives of usefulness in the occupations selected for them; that I believed there would be no serious difficulty in getting the proper legislation for such an institution, and in finding competent, honest, honorable and benevolent gentlemen to act as trustees in it, *if he would found it and act as one of its trustees during his life time*, and that such an institution would probably live and do its work for centuries, if the trustees, carefully selected, were not only authorized but *required* to fill *promptly* vacancies by death or other causes as they occurred. Mr. Seybert was impressed by these views, and at an earlier period of life, and previous to his belief in Spiritualism, when he could have acted as a member of the trust, would probably have adopted them. As it was, realizing that he could not reasonably expect to live more than two or three months, he deemed it best to give up the idea of an early trusteeship for the proposed charity, and do what he could to promote the object in his will which was signed, sealed and executed on the 25th of December last.

A reader of the will will find in one of the last clauses of it, that he directs his body to be "cremated at the Lemoyne Cemetery at Washington, Pennsylvania." I knew that cremation had been for many years preferred by him to the usual mode of sepul-

ture, or any other plan yet adapted for disposing of the human corpse, and here was one of his most remarkable singularities or peculiarities as I termed them in the first paragraph of this memoir: for it was whilst he was considering, or had perhaps determined on, cremation *for himself* that he was planning the transfer of the remains of his father from Paris, where they had for many years previous been interred in [I think] the Père la Chaise Cemetery; and those of his mother from her supposed last resting place many years earlier in Philadelphia, to the older portion of the Laurel Hill Cemetery of our city, where he wished their remains to be interred side by side, and where he expressed to me many years ago the desire that any ashes which might remain from the cremation of his own body should be used in sprinkling their graves, and causing the flowers and turf thus to grow fuller and more perfectly over them! Such was his respectful and affectionate reverence for both father and mother!

Peculiar and even paradoxical as Mr. Seybert sometimes appeared to be, he had the high respect and regard of those who knew him well, and during his last serious illness, he was not only comforted, but his life, it is believed, prolonged by the thoughtfulness of ladies, who sent him delicately prepared food which nourished and sustained him, and without which he would probably have died some months earlier than he did, but which made his more sanguine friends, even

as late as January last, hopeful of his recovery. About that time, it was ascertained by his able physician, Dr. Pepper, that "Bright's disease existed in a latent and "unsuspected form. Although, therefore, he con-"tinued able to drive out daily for some time, and "was able to discuss business subjects, as well as all "other topics, until within a very few days before his "death, he failed gradually but steadily," and his death, which occurred on the 3d of March following, was anticipated by him.

I have said, I think, enough in this memoir to give to those who may read it a fair impression of Mr. Seybert and his peculiarities. I do not think that any one understood him better than myself, or enjoyed more his confidence, and knowing his charitable views I was happy to give him counsel and aid when it was desired by him in investments, or in any other way. For these services he would, I have no doubt, have offered compensation if he had not been satisfied it would be declined, during his lifetime, and would not be expected at his death.

No one could have regarded death more firmly or with more composure, and it pleased the Almighty that his death should not be a painful one. To the last days of his life, he was occupied in charitable acts or suggestions, and directing as to the funeral services to be performed at his house, previous to the transfer of his remains for cremation at the Lemoyne Cemetery. His composure and firmness in death might naturally

have been expected in one who, not only in the close, but during the greater part of his matured life, had been governed in all his acts by a paramount sense *of duty.*

I met with, some years ago in a newspaper, the following lines, of which I have not been able to ascertain the author, but which seemed to me so applicable to Mr. Seybert that I gave him at the time a copy of them, which will probably some day be found among his papers:

I slept, and dreamed that life was beauty,
I woke, and found that life was duty;
Was thy dream then a shadowy lie?
Toil on, worn heart, unceasingly,
And thou shalt find that dream to be
A truth, and noon-day light to thee.

The Zone of Asteroids and the Ring of Saturn. By Professor Daniel Kirkwood.

(Read before the American Philosophical Society, Oct. 5, 1883.)

Evidence in support of the following theses was published by the present writer in 1866–7:

I.

In those parts of the zone of minor planets where a simple relation of commensurability would obtain between the period of an asteroid and that of Jupiter, the original planetary matter was liable to great perturbation. The result of such disturbance by the powerful mass of Jupiter was the necessary formation of gaps in the asteroid zone.

II.

The great division in the ring of Saturn may be explained by the disturbing influence of the satellites, and the more narrow division discov-

ered by Encke may be regarded with much probability as the effect of a similar cause.*

The recent able and noteworthy papers of General Parmentier,† of Paris, and Dr. Meyer,‡ of Geneva, have invested these older discussions of the same subjects with fresh interest and importance. The actual discovery of chasms in the asteroid ring was the result of a previous theoretical determination of the parts where void spaces would be produced by Jupiter's influence. The definite claims of the writer then are:

(1.) To have designated the theoretical positions of gaps in the zone of asteroids;

(2.) To have shown that these divisions actually exist; and

(3.) To have first assigned a physical cause for the divis ons of Saturn's ring.

A restatement of the principal evidence, showing the harmony of recent discoveries with the conclusions announced seventeen years since, is given below. The portions of the ring in which the periods would be commensurable with that of Jupiter are:

1. The distance 3.2776.

At this distance a planetary mass would make precisely two revolutions while Jupiter completes one. Hence, as has been frequently shown, a chasm in the ring would be the probable consequence of Jupiter's disturbing influence. How far is this theoretical inference sustained by facts?

An examination of the table of distances shows

Between 3.083 and 3.220	37	asteroids
" 3.220 and 3.357	0	"
" 3.357 and 3.494	8	"

That is, the part of the zone just within the distance at which a planet's period would be one-half that of Jupiter, contains the extraordinary number of thirty-seven minor planets, while the next space of equal breadth (that containing the distance 3.2776), is a total blank, not a single asteroid having yet been found within it. The exterior space immediately adjacent, and of the same extent, contains eight. The confirmation of the theory is thus most striking in precisely that part of the zone where we have most reason to expect it.

II. The distance 2.5012.

Here an asteroid's period would be one-third that of Jupiter. The order of commensurability would be less simple, but the results of perturbation would be of the same nature. The part of the zone included between the distances 2.30 and 2.80 contains 143 minor planets; 45 within the critical

* See Proc. A. A. A. S., 1866 and 1875; Met. Ast. Ch. xiii; Monthly Notices, R. A. S., Jan. 1869; Proc. A. P. S., vol. xii, p. 163; Smithsonian Rep., 1876; London Observatory, July, 1882.

† L'Astronomie, for June, 1883.

‡ Astr. Nach., No. 2527.

distance and 98 exterior to it. The average interval between adjacent members is 0.00349, while that containing the distance 2.5012—between Thetis and Hestia—is 0.05386, or more than fifteen times the average. Or, if we take spaces adjacent to the chasm and of equal breadth with it, we find twenty asteroids in the interior and eighteen in the exterior.

III. The distance 3.70.

Here five periods of a minor planet would be equal to three of Jupiter. The distance falls in the wide hiatus interior to the orbits of Hilda and Ismene.

IV. The distance 2.82.

At the distance 2.82 five periods of an asteroid would be equal to two of Jupiter. The difference between the two terms of the ratio is three, and hence the conjunctions would occur at angular intervals of 120°. Between the distances 2.753 and 2.803 we find twenty-three minor planets. In the next space of equal breadth, containing the distance 2.82, there is but one. This is No. 188, Menippe, whose elements are still somewhat uncertain. Between 2.853 and 2.903 we find ten asteroids.

Several other gaps have been noticed, but they become less distinctly marked as the cases of commensurability become less simple. Those considered are the only cases in which the conjunctions would occur at less than four points of the asteroid's orbit.

The orbit of Hilda is doubtless nearly, if not quite, the outer limit of the zone. Its mean distance is 3.9523, and in the space immediately beyond—at the distance 3.9683—an asteroid's period would be two-thirds of Jupiter's. It may be observed, moreover, that at the distance 2.063, just within the orbit of Medusa, a minor planet would make four revolutions to Jupiter's one.

Are the Gaps in the Zone Accidental?—In 1870, before half the asteroids now known had been discovered, Mr. Proctor, the well-known astronomer, wrote :

"The question may be suggested, however, is it not possible that the gaps thus apparent are merely accidental, and their accordance with the mean distances simply another accidental coincidence? It may seem, at first sight, that we have not as yet determined the orbits of a sufficient number of asteroids to decide very positively on this point. If another hundred were discovered, it might well happen, one would suppose, that the gaps would be filled up. But, in reality, the doctrine of chances is wholly opposed to this supposition. A law, such as that exhibited in the figure,* does not present itself without a cause. Irregularity is to be observed in all chance combinations, and the figure may be said to exhibit irregularity. But irregularities resulting purely from accident, never by any chance (when a fairly large number of cases is taken) simulates, so

* Mr. Proctor's diagram was merely a graphic representation of the groups and chasms of the zone.

to speak, the operation of law. Therefore we may assume that when many more asteroids have been discovered, the law exhibited in the figure will appear even more distinctly."*

One hundred and twenty minor planets have been added to the list since this passage was written, and, as was then predicted, the chasms in the zone have been rendered the more obvious.

In three portions of the ring the clustering tendency is distinctly evident. These are from 2.35 to 2.46, from 2.55 to 2.80, and from 3.05 to 3.22; containing forty-three, ninety-six, and forty asteroids, respectively. We have thus an obvious resemblance to the rings of Saturn; the partial breaks or chasms in the zone corresponding to the well-known intervals in the system of secondary rings.

The Rings of Saturn.

In the writer's Meteoric Astronomy, published in 1867, the same principle employed to explain the chasms in the ring of minor planets was shown also to account for Cassini's division in Saturn's ring; and, in a paper read before the American Philosophical Society, on the 6th of October, 1871, the division discovered by Encke was explained in like manner. The details of these calculations need not here be repeated, especially as Dr. Meyer has quite recently discussed the whole subject, not only confirming the conclusions of the present writer, but indicating also other parts of the ring where the satellites unite in exercising special disturbing influences. So exhaustive is Dr. Meyer's discussion that "the correspondence between calculation and observation, as to the division of Saturn's rings, would now seem to be complete."

OBITUARY OF JOHN FORSYTH MEIGS, M.D.

By William Pepper, M.D., LL.D.

(Read before the American Philosophical Society, Oct. 19, 1883.)

There are many men who, in their quiet, unobtrusive course, are of incalculable value to the community, and yet who leave but scant material for the biographer. The record of their life-work is to be sought in the cherished recollections of thousands who owe what

* Intellectual Observer, vol. iv, p. 22.

they hold most precious to their skill, energy and devotion.

Nowhere are such men found so frequently as in the ranks of the medical profession. Battles which call for the display of varied knowledge, ready resources, quick resolution, and unflinching courage and self-reliance in the face of tremendous dangers and responsibilities—and for these in such large measure as would win the world's applause if shown on some conspicuous stage—are waged by the physician in many a silent and secluded chamber against disease and death. And the man who turns aside from all allurements of personal ease, and, seeking no notoriety or other reward for his labors, save the consciousness of duty done, and of good results wrought out of perilous conditions, wages ceaselessly such warfare year after year, must rank as truly great.

Eminently such an one was the subject of this memoir, which, as I well know would accord with his own wish, shall be plain and brief in statement. John Forsyth Meigs was born in Philadelphia on October 4, 1818, and died there on December 16, 1882, at the age of 64 years. In an eloquent and instructive memoir of his eminent father, Charles D. Meigs, M.D., which he read in 1872, before the College of Physicians of Philadelphia, a full account is given of the staunch stock from which he was derived. Certainly no one who enjoyed familiar acquaintance with that remarkable man, the elder Dr. Meigs, as I myself

did, though his junior by half a century, could doubt that there would be transmitted to his children unusual and notable traits of mind and character. Of these children it is not fitting that I should now allude to any but the immediate subject of this sketch.

After being educated at Dr. Crawford's well-known school, John Forsyth Meigs began the study of medicine at the University of Pennsylvania, at the premature age of 16 years, and received his degree in 1838, when he was still under 20 years of age. He then served as Resident Physician in the Pennsylvania Hospital for eighteen months, and in April, 1840, he went abroad, remaining until August, 1841, a considerable portion of which time he spent in Paris, enjoying the then unrivaled advantages of that city for students of medicine. Immediately after his return he began the practice of medicine in Philadelphia, and from that time until a few days before his death, he continued the practice of his profession with almost unequaled assiduity.

His chief public service was in connection with the Pennsylvania Hospital, which institution he served as Attending Physician from 1859 to 1881, when he resigned* and was succeeded by his son, Dr. Arthur V.

* Resolutions passed Nov. 28, 1881, by the Board of Managers of Pennsylvania Hospital upon the resignation of Dr. J. F. Meigs:

Dr. John F. Meigs having presented his resignation as one of the attending physicians of this hospital, which, at his request, has been accepted, it is therefore

Resolved, That this Board desire to record their grateful recognition and appreciation of the faithful and efficient work done by Dr. Meigs in

Meigs. He was also Consulting Physician to the Women's Hospital, to the Blind Asylum, and to the Children's Hospital.

The services he rendered to the Pennsylvania Hospital were most devoted and loyal, as has been the case with so many of those connected, as managers or as members of the medical staff, with that venerable institution. For many years Dr. Meigs sacrificed a large part of whatever summer recreation he otherwise might have enjoyed, for the opportunity of devoting to the cases in his hospital ward more time daily than would have been possible had he chosen a term of service during the months when his private practice was most pressing in its claims.

He was a model Hospital Physician. His manners to the poor sick seamstress or servant girl in his ward were as kind, courteous and attentive as though he were in the chamber of his wealthiest patient. The care given to the study of each case, though with no thought of preparation for publication, was most thorough and minute.

the various positions in the medical department of this hospital, which he has filled for twenty-five years past, and which has added largely to the reputation our Institution now enjoys.

Resolved, That in addition to the faithful discharge of all his official duties, this Board recognizes the obligations of this hospital to Dr. Meigs for other ways in which he has testified his interest for the Institution,—notably in procuring for it pecuniary aid, and in the thorough manner in which he has completed the historical record of the hospital to the year 1876.

Resolved, That a copy of these resolutions be engrossed, signed, on behalf of the Board, by the President and Secretary, and sent to Dr. Meigs.

An insatiable reader of medical literature, he was ever acquainted with the latest views as to the nature and treatment of disease, and while his extensive opportunities of observation had rendered him conservative and critical of mere theory, he was always willing to recognize and profit by real advances in the healing art.

He employed a special assistant, whom he paid liberally, to make full records of every case under treatment in his wards, and I have had many opportunities of knowing that these records, embodying as they did his own accurate observations, and wise or ingenious suggestions, were admirable specimens of clinical work. But here, as in all his medical work, it was clear that his great and abiding interest was the welfare of his patients, and the actual relief of their sufferings.

During the entire period of his connection with the hospital, he took his full share of the public clinical teaching, which has been carried on there for 107 years. His lectures were unlike any others to which I have listened. With no pretence at oratorical effect, but with, on the other hand, the most perfectly natural and conversational style, there was such an air of candor and utter truthfulness, so much delicate and refined disclosure of his own nature and thoughts, upon many other subjects than the medical question immediately under discussion; such varied and rich illustration of the question from the stores of a curiously retentive memory, charged with all the details of

thousands of instructive precedents; and, above all, such uniform advocacy of the purest and highest and most disinterested aspects of medical work, as combined to render these lectures strikingly suggestive and valuable. But in addition to this routine work, though done with such spirit and enthusiasm as showed that it was always fresh to him, there were occasionally important original investigations suggested by him and carried out with his assistance. The most extended and complete of these special studies was that upon "The Blood in Malarial Fever," which was based upon an unusual series of cases of severe malarial fever from Southern seaports admitted to the Pennsylvania Hospital in 1866. The results of this investigation were highly important, and established, certainly for the first time in this country, certain additional facts in regard to the nature and mode of action of this singular poison. It was characteristic of the liberality and courtesy with which Dr. Meigs invariably treated his junior colleagues, that in publishing these results he insisted upon the names of his collaborators, who were then the resident physicians serving under him in the hospital, being associated in the authorship. How many times have I heard him, when about to leave the hospital, after several hours enthusiastic work in the wards, in the microscope room, or in the pathological laboratory, exclaim that if it was only possible he would prefer infinitely to spend his life in a hospital, devoting himself to original researches

upon the nature and treatment of disease, to any other conceivable plan of existence. I have mentioned these details because they illustrate the character of the man, and indicate the value of his public services, and especially of his influence upon all those who were fortunate enough to be brought into close contact with him in the discharge of these duties. It is no small tribute to the genuineness and disinterestedness of a man's devotion to science that, year after year, when overburdened with lucrative professional work, he should forego pleasure and much needed rest to spend laborious hours in such eager study in hospital wards as would stamp with distinction a young and enthusiastic investigator.

I have incidentally alluded to some of Dr. Meigs' writings, but it may at once be stated that, although not a voluminous author, he possessed admirable literary qualities and a most attractive style. The fact that he never sought any chair in either of Philadelphia's great medical schools, and that from an early age he was absorbed in the cares and fatigues of a large private practice, explain why he wrote no more and, why, with one notable exception, his writings were not of an elaborate character. He suffered also, as the sons of greatly distinguished men must do, from being viewed as an author in comparison with his gifted father, who was one of the most eloquent and facile writers ever produced by the medical profession of this country. But in fact the writings of Dr. John Forsyth Meigs

stand successfully the strictest criticism. As an example of his style, and as proof that he possessed literary gifts which, if leisure had been afforded, or if his ambition had been in the direction of more frequent publication, would have won him high rank as a writer, I would refer again to the memoir of his father, which seems to me a charming piece of biographical writing, abounding in evidences of correct taste and of delicate delineation of character, and written throughout in a pleasing, vivacious and sustained style of narrative.

The following list comprises the more important of his shorter writings:

April, 1847. History of Seven Cases of Pseudo-membranous Laryngitis or True Croup; with Remarks on the treatment, and the distinction between it and other Laryngeal Affections of Children. Vol. 13, N. S. Amer. Jr. of Med. Sciences, page 277.

October, 1848. A Practical Treatise on Diseases of Children.

April, 1849. History of Five Cases of Pseudo-membranous Laryngitis or True Croup, in three of which Tracheotomy was performed. Vol. 17, N. S. Amer. Jr. of Med. Sciences, page 307.

November, 1850. Pneumonia in Children. Vol. 1, N. S. Trans. Coll. of Physicians and Surgeons, page 5.

June, 1852. Remarks on Atelectasis Pulmonum, or Imperfect Expansion of the Lungs, and Collapse of the Lungs in Children. Vol. 23, N. S. Amer. Jr. Med. Sciences, page 83.

October, 1856. History of Three Cases of Intermittent Fever, Showing the Natural Course of the Disease. Med. Examiner, page 56.

October, 1859. Remarks on Chronic Gastritis, Duodinitis and Colitis. Vol. 1, Proc. Path. Society, page 243.

September, 1860. Clinical Lecture on Diabetes Mellitus, delivered at Pennsylvania Hospital.

June, 1860. Remarks on Transposition of Arteries. Vol. 2, Proc. Path. Society, page 37.

January, 1861. Remarks upon Intestinal Concretions in the Appendix Cæci, causing Perforation and Fatal Peritonitis. Vol. 2, Proc. Path. Society, page 77.

April, 1864. Heart-clot as a Cause of Death in Diphtheria. Vol. 47, N. S. Amer. Jr. Med. Sciences, page 305.

October, 1865. On the Pathological Appearances presented in Marsh Fever. Vol. 50, N. S. Amer. Jr. Med. Sciences, page 305.

April, 1868. On the Morphological Changes of the Blood in Malarial Fever, with Remarks on Treatment. Vol. 55, N. S. Amer. Jr. Med. Sciences, page 475.

January, 1869. History of Two Cases of Embolism; in one following Scarlet Fever, with recovery; in the second, connected with Disease of the Aortic Valves and Coarctation of the Thoracic Aorta, ending fatally. Vol. 57, N. S. Amer. Jr. Med. Sciences, page 24.

January, 1869. Address on the Opening of the New

Lecture and Operating Room of the Pennsylvania Hospital. Published September, 1871.

July, 1869. History of Two Cases of Cerebritis; one from unknown cause, the other traumatic, with recovery under active depletion. Vol. 58, N. S. Amer. Jr. Med. Sciences, page 146.

November, 1872. Memoir of Charles D. Meigs, M. D. Vol. 1, N. S. Trans. Coll. Phys. and Surg., page 417.

January, 1875. A Case of Pneumo-Hydropericarditis. Vol. 69, N. S. Amer. Jr. Med. Scs., page 81.

September, 1876. A History of the First Quarter of the Second Century of the Pennsylvania Hospital.

September, 1878. Atelectasis Pulmonum. Proc. Obstet. Society.

January, 1879. Cases of Collapse of the Lungs and Cyanosis in Young Children. Amer. Jr. Obstetrics, Vol. 1, page 79.

February, 1880. Lecture on Water.

1880. Annual Address before the Alumni Society of the University of Pennsylvania.

The work, however, by which Dr. Meigs will be longest and best known, is the treatise on "Diseases of Children," the first edition of which was published in 1848, and which immediately attained the position of a standard authority. A second and third edition appeared in rapid succession, and were quickly exhausted, after which, owing to his excessive occupation, it was allowed to become out of print. In 1869, he requested

me to associate myself with him in the task of bringing the work up to date, and the fourth edition, which appeared in 1870, has been followed by three others, the last having been published in 1882. The estimation in which this has come to be held may be appreciated from the language of the London *Lancet:* "It is a work of more than 900 good American pages, and is more encyclopædical than clinical. But it is clinical, and withal most effectually brought up to the light, pathological and therapeutical, of the present day. The book is like so many other good American medical books which we have lately had occasion to notice; it marvelously combines a résumé of all the best European literature and practice, with evidence throughout of good personal judgment, knowledge and experience. There are few diseases of children which it does not treat of fully and wisely in the light of the latest physiological, pathological and therapeutical science."

But unquestionably, it is as the wise and trusted physician that Dr. Meigs will be most vividly and fondly remembered, so long, at least, as any of those survive who had the benefit of his ministrations and advice. I doubt whether there could be found, in any other large city, prominent physicians occupying precisely the relation to the community which has, for a hundred years past, been borne by a succession of eminent medical men in Philadelphia.

For the most part, as communities enlarge, the leading physicians are forced by the demands upon their

time to assume more and more the role of consultants, and to abandon, in large measure, the more intimate and personal relations with their patients which is occupied by the family physician. But in this city, despite its rapidly enlarging proportions and population, the case has always been different. There have ever been physicians in Philadelphia, whose important hospital positions, popular and authoritative writings, and eloquent teachings, have combined to render deservedly illustrious, but who have continued willing to devote themselves to the daily routine of family practice. It need not be indicated that such a course has displayed singular unselfishness; since such combined labors have involved almost superhuman exertions and application, while their personal services have been rendered for remuneration scarcely greater than that received by their less experienced and less eminent colleagues. But this self-sacrifice and devotion to the interests of their patients, has been repaid by a degree of affectionate gratitude and loyal attachment on the part of the community, which has rendered almost unique the position of the leading medical men of Philadelphia. Of this long line of distinguished practitioners Dr. John Forsyth Meigs was an excellent example, and it is scarcely too much to say that, owing to a variety of causes which cannot be here discussed appropriately, he was the last of that line. Whether the people of Philadelphia will gain or lose more by the changes which, during the past decade, have rapid-

ly come over the relations between the medical profession and the community, is an open question. But it is evident that such changes were unavoidable, and the only matter of surprise is, that they could have been postponed so long by the conservative spirit, so strongly prevalent here, and by the respect paid by the medical profession to its deeply rooted traditions. In this relation of trusted and confidential adviser, Dr. Meigs could not have been surpassed. Of spotless integrity and purity of character; with a lofty conception of his duty as a physician, and with unselfish devotion to the pursuit of medical science; with such courtesy and charm of manner and conversation as made him one of the most agreeable companions; with infinite tact, patience, gentleness and sympathy with the sick and suffering; and yet with firmness of will, vigorous energy, calm and dignified self-reliance which commanded implicit confidence and obedience in the hour of most urgent and deadly danger; it is not easy to conceive or portray the large and important place such a man filled in the lives and affections of hundreds or thousands who cherished him as their physician. I well know that this poor tribute would be re-echoed in stronger and warmer accents from many a sick chamber, which is to-day deprived of its brightest cheer and strongest comfort through his death.

But few details of his private life need be added to this sketch. He was married Oct. 17, 1844, to Miss Ann Wilcocks Ingersoll, daughter of the late Charles

J. Ingersoll, Esq., and was so unfortunate as to lose this amiable woman by death on Dec. 30, 1856. He remained faithful to her memory and never married again. Eight children were born to him, of whom the eldest and the youngest died. His son, Dr. Arthur V. Meigs, after graduating at the University of Pennsylvania in 1871, has devoted himself with signal success to the profession followed by his distinguished father and grandfather, and already occupies the same important public positions in connection with the Pennsylvania and Children's Hospitals, which were formerly held by his father.

His habits of life were extremely simple and almost austere. He clung to the simplicity of his early days, and lamented the luxury of our own time. His constant and absorbing occupation, as well as his own tastes, prevented him from moving to any considerable extent in general society, or, during his later years, from even attending the meetings of the scientific or medical societies to which he belonged. Although he worked incessantly and arduously, it is certain that his strength was never great nor his health robust. He had two serious illnesses, pleuro-pneumonia in December, 1854, and a second attack of pneumonia, complicated with hemorrhage from the lungs, in December, 1863. His last illness was also pleuro-pneumonia, which was contracted in December, 1882, by exposure during a professional visit, when he was reduced by a heavy cold; it ran a rapid course, and ended fatally on the eighth day.

Stated Meeting, October 19, 1883.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Fayenbaya Observatory (112), the Pennsylvania Historical Society (113), and the Franklin Institute (Cat.).

A letter of envoy was received from the United States Department of State for the Government of the Netherlands.

A letter from Edmund de Schweinitz, President of the Society for the Propagation of the Gospel among the Heathen, dated Bethlehem, Pa., October 9, 1883, requesting the return of the Zeisberger and Perlæus MSS. to their owners, was read and referred to the next Stated Meeting for consideration, the Curators being instructed to examine into the subject in the meantime and report. (See page 284.)

Donations for the Library were received from the Royal Academy of Science at Rome; Royal Venetian Institute; Société de Géographie and Revue Politique, at Paris; Société de Geographie Commerciale, Bordeaux; Observatory at San Fernando; London Nature; Boston Natural History Society; Rhode Island Historical Society; New York Academy of Sciences; Cornell University; Journal Medical Sciences; Chemical Journal; United States Naval Institute; United States National Museum; and Mr. H. T. Cresson, of Philadelphia.

An obituary notice of Dr. John Forsyth Miegs was read by Dr. William Pepper. (See page 266, above.)

Mr. T. U. Walter was excused from preparing an obituary notice of the late John Trautwine, as he had already read one before the Society in Washington, which would be published.

The death of Dr. J. Lawrence Smith, at Louisville, Ky., October 12, aged 64, was announced.

A memoir entitled "The history of the Mexicans, from their Paintings," was communicated by Mr. Henry Phillips, Jr., being an annotated translation of the Ramirez MS.

A memoir on the "Course and growth of the fibro-vascular bundles in Palms," by J. C. Branner, was read by the Secretary.

Dr. Frazer exhibited a map of Radnor township and the adjoining districts of Delaware and Chester counties, on which he had delineated the Sienite belt and the outcrops of Serpentine, the stratigraphical relationships of which he discussed, dissenting from Mr. Rand's theory of their echelon structure and exogenous origin.

A communication was read from Mr. Hillborn T. Cresson, of the Academy of Natural Sciences of Philadelphia, respecting the minutes of March 15, 1883, Proceedings of American Philosophical Society, pages 648, 649.

"The statement that the instruments in question were studied by Mr. Cox is a mistake. The gentleman above named (Mr. Cox) was employed by me as a professional musician to verify and illustrate, with the Boehm flute, the points of a lecture upon Aztec music, delivered by me, before the Academy of Natural Sciences of Philadelphia during their seance of April 17th, 1883, having previously furnished him with a score showing all the notes, fingering and stoppings necessary, and by reference to which he so manipulated the instrument in question that, upon the Mexican *flutes* or *flageolets* the entire *chromatic scale* was obtained; and upon those instruments denominated by me pitch-pipes or whistles (made of like material) an octave was obtained; also, a *ninth*, eleventh and twelfth, the tenth note being missing (or the instrument made to produce it lost, or otherwise destroyed, and it will rest with musical experts to determine whether this note really existed). It is due Mr. Cox to state, that I mentioned him in my pamphlet entitled 'Aztec Music,' on account of the valuable hints he gave me in regard to modern music, formation of orchestras, &c., as my musical knowledge is limited. It was simply my intention, as an archæologist, to call the attention of musical experts to facts first observed by me while arranging certain collections of antiquities in France and Italy, trusting that they might be of interest, and serve to aid investigations in this branch of ethnology, about which little is known at present. It is necessary to make a distinction between the two kinds of instruments borrowed by me from your Society, as they are entirely different in construction and character, viz.: four-holed flutes, made of baked clay or terra-cotta, and those instruments of like material, which I have denominated 'pitch-pipes,' both kinds of which instruments are of Mexican origin. I beg leave to ask that, at your next stated meeting,

you will kindly correct the mistake above shown and published in your Proceedings, and kindly insert the following, viz.:

"'The Curators reported the safe return of the four-holed Mexican flutes or flageolets of terra-cotta, and the "pitch-pipes" or whistles of like material, which were borrowed and studied by Hillborn T. Cresson, who found that the first-mentioned four-holed clay flageolets could be made to produce the entire *chromatic* scale by proper manipulation and finger-stopping. The Mexican whistles or pitch pipes gave in regular succession, from tonic to octave, a full diatonic scale; also, a ninth, eleventh and twelfth existed, "*the tenth being absent,*" giving in all an *octave* and a *quarter.*'

"I regret to say that this is somewhat long, yet the facts deduced by the investigation of these instruments, owned by your honorable Society, prompt me to ask you to record them, merely claiming that they are interesting facts, *and, if I am correct, first noticed by myself.* Please state to your Society that, for the past eight months, I have devoted my spare time to the arrangement and classification of the Mexican antiquities contained in the Poinsett and Keating Collection, and that I hope in a few weeks to have these unique specimens of art so arranged that they can be properly labeled and catalogued."

Pending nominations, Nos. 985 to 1006, were read.

And the meeting was adjourned.

Stated Meeting, Nov. 2, 1883.

Present, 9 members.

President, Mr. FRALEY, in the Chair.

After reading the minutes it was resolved that the Secretaries be instructed to cancel the concluding part of the rough minutes of the last meeting.

Letters of acknowledgment were received from the Royal Society at London (102, 110 and 111 to complete set), and the Statistical Society, October 15 (112).

A letter of envoy was received from the United States Naval Observatory.

Donations for the Library were received from the Geological and Trigonometrical Survey of India, the Danish Society of

[illegible]; the Congress of Americanists; the Societies at Königsberg, Giessen and Geneva; the Geographical Societies at Vienna, Paris, Bordeaux and London, the Royal Academies at Berlin and Dublin; Zoological Societies in Paris and London; Professor Paul Albrecht, of Brussels; Revue Politique and Revista Euskara; the Royal, R. Asiatic and Linnean Societies in London, Greenwich Observatory, Cornwall Polytechnic Society, Boston Natural History Society; American Academy of Sciences; American Journal of Science; New York Observatory, United States Observatory; Franklin Institute; Mr. Henry Phillips, Jr., and the Mexican Museum.

The death of Oswald Heer, of Zurich, at Lausanne, September 27, aged 74, was announced by the Secretary; the reading of a letter from Mr. Leo. Lesquereux, of Columbus, was postponed to the next meeting. (See page 286.)

The death of Joachim Barrande, at Prag, aged 83, was reported by the Secretary.

Mr. Chas. A. Ashburner gave a brief description of Dr. Kintses's fire-damp indicator which he had recently examined in conjunction with a Committee of the Franklin Institute.

Although he did not feel at liberty to state the conclusions to which the Committee had arrived in regard to this special apparatus, he expressed grave doubts as to the practicability of any such appliance to prevent mine explosions from fire damp, and the consequent loss of life. Fire damp is not the most deadly foe of the coal miner as is popularly supposed. It is an acknowledged fact that anthracite contains the greater quantity of fire-damp, and greater risks from gas explosions are experienced in anthracite mines.

He stated that in the decade from 1860 to 1870 less then 11 per cent of the fatal accidents in the Pennsylvania anthracite mines resulted from fire-damp explosions; while during the year 1882 only 8½ per cent of the fatal mine accidents were to be attributed to this cause. In most cases the fire damp, whose presence was already known, and therefore no automatic indicator was necessary to locate it, was fired either through the carelessness or recklessness of a miner, from a neglect to comply with the superintendent's orders, or from criminal disobedience to the mine laws.

In his judgment, in no case during the year 1882 would an automatic indicator have prevented an explosion. The greatest foes of the coal miner are his negligence, his disobedience and his recklessness.

The experience of the English miner with automatic fire-damp indicators, particularly Ansell's, which the speaker thought a more sensitive fire-damp detector than Dr. Kintses's, goes to prove that the use of such instruments is not practical. The mine laws if rigidly enforced would diminish the risk of fire-damp explosions and the resulting loss of life more than any other means. The experience of Mr. Ashburner in fiery mines was adduced in support of his views.

The reading of pending nominations Nos. 985 to 1006 was postponed.

The Report of the Curators on Bishop de Schweinitz's letter was read and accepted, and the resolution recommended therein was agreed to. (See below.)

Mr. Fraley reported that he had received and paid over to the Treasurer the interest on the Michaux Legacy due October 1st, amounting to $132.43.

Mr. Lesley was authorized to insert in the minutes the following correction of the note in his communication on the Progress of the Second Geological Survey of Pennsylvania, in Chester county, read January 19, 1883 (Proceedings No. 113, page 539, lines 17, 18), which he desired to have read as follows:

"The delay in the publication was caused by an unforseen and unavoidable delay in the receipt of Dr. Frazer's notes which form the latter part of the volume."

A Committee of five, consisting of Dr. Brinton, Mr. Price, Dr. Horn, Mr. Phillips and Dr. Frazer was appointed to report what improvement, if any, can be made in the mode of balloting for members, and the meeting was adjourned.

Letter of Bishop de Schweinitz.

To the President and Directors of the American Philosophical Society:

GENTLEMEN: In accordance with a resolution adopted by the Directors of the "Society for Propagating the Gospel among the Heathen," I herewith respectfully request you to return, at your earliest convenience, the seven Manuscripts by Zeisberger and Pyrlæus on Indian languages, which Manuscripts are the property of said Society, and which were deposited in your Library subject to a call from our Board. Their titles and the fact that they were deposited by our Society, are set forth in Vol. I of your Transactions, 1819. I inclose a list of these Manuscripts.

The reason why we now claim them is, that the Church has made com-

plete arrangements for preserving all its documents and papers here at Bethlehem; that its library and collection of manuscripts are properly ordered and displayed in its "Archives;" that a most valuable library of Moravian literature has recently been presented to us; and that we wish to bring together all the papers which we own, especially with regard to the Indians, and arrange them in our collection. At the time that the Manuscripts for which we ask were deposited with the American Philosophical Society, none of the conveniences existed which we now have for preserving such documents.

I remain, gentlemen,

Yours, very respectfully,

EDMUND DE SCHWEINITZ,

President of the S. P. G.

BETHLEHEM, PA., October 9th, 1883.

Transactions of the American Philosophical Society, Philadelphia, Vol. I, 1819. By its Historical and Literary Committee.

p. xlvii. "*Deposited by the Society of the United Brethren of Bethlehem:*"

1. Deutsch und Onondagoisches Woerterbuch, von David Zeisberger. 7 vols. 4to.

p. xlviii. 2. Essay of an Onondago Grammar, or a short introduction to learn the Onondago, alias Maqua Tongue; by David Zeisberger. 4to, 67 pp.

3. Onondagoische Grammatica; by the same. 4to, 87 pp.
4. Another Onondago Grammar in the German language; by the same. 4to, 176 pp.
5. Affixa Nominum et Verborum Linguæ Macquaicæ. Auctore Chr. Pyrlæo. 4to, 25 pp. [With this work are bound several Iroquois Vocabularies and Collection of Phrases, the whole together making 178 pp. 4to.]
6. Adjectiva, Nomina et Pronomina Linguæ Macquaicæ, cum nonnullis de Verbis, Adverbis ac Præpositionibus ejusdem linguæ. Pyrlæus. 4to, 86 pp.
7. A Collection of Words and Phrases in the Iroquois or Onondago Language, explained into German. By the Rev. Chr. Pyrlæus. 4to. 140 pp.

Report of the Curators on the subject of the Zeisberger and Pyrlæus MSS. November 2, 1883.

It appears to the Curators that these MSS. were deposited by "The United Brethren of Bethlehem," and therefore cannot be given up except to them or by their order. The present demand comes from the "Society for Propagating the Gospel among the Heathen." We have, therefore, no right to surrender these MSS. to an alien Society.

If the "Society for Propagating the Gospel, &c.," be the successor of "The United Brethren," we should be formally and legally notified to that effect, and likewise the resolution of request should be under seal. If we were to accede to this demand without a greater knowledge of the circumstances we might be liable to a demand from the real owner of these MSS. with which the Society could not comply. We, therefore, recommend that the Society adopts the following resolution:

That Bishop Schweinitz be requested to inform the Society by what right the "Society for Propagating, &c.," demand from us these MSS. deposited by "The United Brethren."

PHILLIPS,
GEO. H. HORN, } *Curators.*

Nov. 2, 1883.

Notes of Reference Appended.

Deposited, 1819. Trans. Vol. I, page

1865. Dec. 1. (Proc. Vol. X, p. 187.) D. W. Fiske writes in relation to the Zeisberger MSS.

Dec. 15. (Proc. Vol. X, p. 193.) Letters read in reference thereto. Contents not given.

Literary Committee made a recommendation which was referred to the Secretaries to report on.

1866. Feb. 16. Vol. X, p. 205. The Secretaries reported they had found these MSS. noted as deposited, &c. The United Brethren were requested to allow the American Philosophical Society to publish them.

March 2. (Vol. X, p. 207.) Mr. Fraley states that the United Brethren desired themselves to publish these MSS.

March 16. A letter from Bethlehem *in ea re* read.

The matter ended there, and nothing further appears on the minutes to this day.

PHILLIPS,
GEO. H. HORN, } *Curators.*

Nov. 2, 1883.

Letter of Leo Lesquereux.

Oswald Heer, the celebrated Professor of Zurich, was born at Glaris in 1809. His father was a doctor. He first studied theology, and was ordained as minister, but afterwards studied medicine, and became interested in the science of Natural History. He has lived at Zurich since 1832. In 1837 he was Professor either at the University or at the Polytechnic School, and Director of the Botanical Garden. He was for a few years a member of the Council of Zurich, but resigned his seat to be able to attend to his studies. In 1869 Zurich received the celebrated scientist as citizen (member of the city Bourgeoisie).

...f communication of the family, 29th September, says only

this: "Prof. Dr. Oswald Heer was called to God at the age of 74 years, 27 days, after a short illness. He died at Lausanne on the 27th." Berthoud, who writes me also on the 29th, gives me a few details on Heer's last days. He says: "I come to be with you to deplore the loss of your friend and to share your sorrow. Heer is dead. He was of late very tired. In order to get some rest he went to Montreux, that fine warm place on the borders of the Lake of Geneva, where he expected to regain some strength for new works. There he had after a few days an attack of bronchitis. Well knowing the danger of that disease for a man advanced in years, he hurried to his brother at Lausanne, where he died the day after his arrival."

Heer had worked the whole winter beyond human forces, to bring to a close the seventh volume of his Arctic Flora which came out in July. The great Swiss exposition of industrial products, held at Zurich, gave him constant occupation and some excitement by the numerous visits he received. The meeting of the Society of Natural History of Switzerland of which he was President was also held at Zurich, increasing his work of course, and forcing him to long and severe exertion. In his last letter, end of August, he writes me that his task is nearly finished, and that he feels that it is time to close his work.

A Swiss journal announcing the death of Prof. Heer says, that the loss is irreparable, and this expression is echoed by many. The loss of a member of our poor humanity is never irreparable; that of Heer has left a vacant place which will be unoccupied for a long time to come. Why? Allow me to trace a short outline of his career as the more fitting answer to the question.

I know little of the early years of the celebrated Professor of Zurich. His family came from St. Gall. He studied first theology in Zurich I believe. But then, prompted by his ardent love of nature, he abandoned his calling for the study of entomology and botany. From the beginning of his career, he took a high standing in the world of science by the publication of a memoir on the relation of the insects with the plants, enumerating and describing a large number of species of plants with the insects related to each by their habitat, their food, their mode of life, etc. He had already given his attention to fossil botany, when, in 1848, he began to collect materials for the preparation of a fossil flora of Switzerland and the adjoining countries. He went to work, helped by most favorable circumstances: by the rich collections of the Museum of Zurich; by the communications of numerous friends, among them the celebrated Alex. Braun, later Professor of Botany at the University of Berlin, and Director of the Botanical Garden; especially by the resources of a rich lady, Mrs. von Buman. This lady, endowed with a great love of science and of admiration for the works of Heer, who was already a professor of reputation, opened upon her property near Lausanne quarries and tunnels for the discovery and collection of fossil plants, materials which were sent to Zurich by tons to be studied by Heer. A large part of the specimens figured in

the *Flora tertiaria Helvetica* came from that source. One cannot read without a deep feeling of admiration a note of thanks written by Heer in honor of that lady in the beginning of the third volume of that work. The third volume ends the Tertiary Flora of Switzerland. The work was then supposed to be complete, but a fourth volume, *Flora fossilis Helvetica* was published in 1876, containing descriptions and figures of plants of the Carboniferous, the Trias, the Jurassic, the Cretaceous and of the Eocene of Switzerland. This great work in 4to, with a very large number of splendid plates, is too well known to demand description. It has given to the author the first place in the ranks of Phytopaleontologists of our time.

A kind of antecedent résumé of this work was already published in 1865 under the name of *Die Urwelt der Schweitz* (the Ancient World of Switzerland). It is a large F° volume of 600 pages, splendidly illustrated by figures representing fossil remains of plants and animals of the different geological periods. The best proof of the worth of the volume is the fact that though relating only to the paleontology of the geological formations of Switzerland, the book has had already three or four editions, and been translated into six different languages.

At this time Heer was requested by professors and directors of museums to determine and describe numerous collections of fossil plants, and as a result of his researches published many separate memoirs on the plants of divers localities of Europe. Among the more important ones I may mention: The Flora of the clays of Borey Tracy, England (1861). The Baltic Miocene flora; the Eocene flora of Bornstaedt (1863 and 1869). The Cretaceous flora of Moletin; that of Quedlinburg (1871). The Phyllites cretaciés of Nebraska, the Fossil flora of Alaska, the fossil plants of Vancouver, contributions to the fossil flora of Sumatra, and a number of others, half a dozen of which are mentioned in the catalogue of Heer's work by Schimper.

During this time Heer was already at work on his most important production, the *Flora fossilis Arctica*, which, begun in 1862, was finished by the publication of the seventh volume a few months before his death.

Considering only the large number of the publications of Heer, they already constitute a weighty monument as the result of the life of a man. But that number is not the essential value. Other paleontologists, Brongniart, Sternberg, Unger, Goeppert, Schimper, Lindley and Hutton, among the illustrious dead, have left works which may be compared to those of Heer, though in a far reduced degree of value. None of them, however, has raised fossil botany to a high degree of importance in the scientific world. None of them has, like Heer, opened new fields for the exercise of the mind, and prepared for vegetable paleontology an honorable place in the domain of science enlarged by researches in that specialty.

In the Arctic Flora Heer has brought to light, for the polar regions of Greenland, Spitzberg, Sachalin, a subtropical vegetation, attesting, during the Tertiary period for those northern regions, a climate about like that of Florida and the Gulf shores at the present time. He has recog-

nized an analogous kind of vegetation in following the data furnished by remains of fossil plants southward to the shores of the Baltic sea, and even to those of the Mediterranean in Italy. This fact of course concerning the distribution of plants during the Miocene or Tertiary period has forcibly modified the views formerly admitted respecting the physical circumstances which have governed the earth during geological times, and has compelled physicists and geologists to renew their researches for the solution of important problems concerning the distribution and the cause of heat, and changes in the temperature of the globe. Heer has described also a Cretaceous flora from Greenland bearing evident relation to that of the same period observed in North America and in Europe; a flora representing a number of types which, persisting through the floras of the more recent formations, are still present in the North American vegetation of the present epoch. He has thus evidenced by his Arctic flora the gradual development of vegetable types since the times when the first traces of dicotyledonous plants are recognizable. He has compelled the admission of vegetable paleontology into the domain of geology by the manifest determination of the age of any formation from the characters of its plants only. With only one mistake on that subject has he been unjustly reproached, viz., his reference to the Tertiary of three or four Cretaceous leaves of which he had merely poor sketches to base his determination on.

The noble character of Heer has greatly contributed to give to his works a degree of authority superior to that acquired by any paleontologist before him. Simple, modest in the highest degree, of a serious though contemplative mind, his life was resumed on the fulfillment of the duty of every day. When the University of Switzerland was established at Zurich, he had been named Professor of Natural History and Director of the Museum. His lectures at the University were always followed by a large number of students; so full of interest were they that even strangers and common town-people requested the privilege of attending them. He never missed an opportunity to show his deep interest in the scientific and moral progress of the students. Even in his days of sickness (for all his life he has had to fight against attacks of severe illness), he gave his lessons in his own room, lecturing from his bed. He had been called once by his countrymen to a highly honorable position as a member of the Council of State; but he found that the new duty required too much of his time, and he gave in his resignation in order to continue without hindrance his scientific pursuits.

What can I say more of the friend with whom I have been in intimate relationship long years. Heer united in himself a powerful intellect, trained by severe studies, with the simplicity of a child and the conscience of a true Christian. His works are the expression of the principles of his life.

L. Lesquereux.

Stated Meeting, November 16, 1883.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Mr. P. C. Garrett was introduced to the presiding officer, and took his seat.

A photograph of the Chev. Damiano Muoni was received through Mr. Phillips for insertion in the album.

Letters of acknowledgment were read from the Boston Public Library (XVI, i); American Antiquarian Society (XVI, i); New Jersey Historical Society (XVI, i); United States Military Academy (XVI, i); State Historical Society of Wisconsin (XVI i,), and the University of the city of New York (113, i).

A letter of envoy was received from the Academy of Sciences at Rome.

Donations for the Library were reported from the Mining Engineers at Melbourne, Mad. C. Royer of Paris, the Geographical Commercial Society, Bordeaux; the Geological Society and Señor Goodolphim of Lisbon; London Nature; American Astronomical Society, Boston; Harvard University; Mr. Scudder, Mr. Phillips, the Brooklyn Library, the American Chemical Journal, Mr. Gatschet, the editor of Scandinavian, and the Astronomical Observatory of Mexico.

Dr. Brinton read an obituary notice of Oswald Heer, in a letter from Mr. Lesquereux to Mr. Lesley.

The death of Dr. John Lawrence Le Conte, one of the Vice-Presidents of the Society, at Philadelphia, November 15th, aged 58 years, was announced by the Secretary.*

* John Lawrence Le Conte, the son of Dr. John Le Conte, was born May 13th, 1825, in New York, and graduated at the College of Physicians and Surgeons in 1846. He traveled extensively on this continent on tours of scientific investigation. He served as surgeon and medical director in the volunteer and regular armies during the war of the Rebellion. In 1873 he was elected President of the American Association for the Advancement of Science. He was an active member of the Academy of Natural Sciences in Philadelphia. Dr. Le Conte was a son-in-law of the late Judge Grier, of the United States Circuit Court.

Mr. Lesley desired to express his feeling that while the Society has sustained a serious loss in the death of one of its estimable Vice Presidents, science has suffered a lamentable blow by the withdrawal of one of the best investigators and one of the truest philosophers that ever did duty in her service. Not a common soldier only has fallen—not a non commissioned officer not a mere colonel of a single regiment in her army—but a general of high rank, a leader of forces, one who could plan and execute the manœuvres of a large and long campaign, an organizer, a ruler in her realm

My private grief, said the speaker, at the loss of an old and intimate personal friend gives me no peculiar right to tell his virtues and abilities in this hall where he has been known and honored for so many years, but it gives me the power to speak of these virtues and abilities with the confidence of absolute knowledge. Others have known and loved him, and will regret his death, and will speak of him affectionately and respectfully inside and outside of this hall But it was my good fortune to be one of his special companions for the past thirty years, and he often expressed the wish that if I survived him I would place on record some memorial of his life Once, when I felt vigorous and hopeful, I promised to gratify his wish, although he was the younger of the two, and had a natural right to give what he desired to receive. But now, how is it possible to do more than say, "Le Conte is dead, the precocious youth, the affectionate son, husband, father and friend, the just and truth loving man, the accurate and precise observer, a master in the divine art of classifying facts, a perfectly trained and nobly developed genius in science."

Le Conte is a famous name in American science The foundations of its fame were laid by the father, and built up by the son. Both these have passed away from the eastern shore of the continent; but on its western shore two brothers, children of the father's brother, prolong and enhance the reputation of the name.

A memorial of the life of our fellow member and friend would be incomplete without a personal description of old Major Le Conte, to whose vigorous intellect, excellent common sense, and great experience in zoological studies, John owed not only his extraordinary abilities, his aptitude for mathematics, his eye for form and color, his exactness, his imagination, his love of the study of languages, his taste for historical metaphysics, and especially mythology, and his pronounced capacity for practically putting things in order and managing affairs, but also the opportunity for cultivating and displaying all these various, and, as many people vainly imagine, contradictory mental powers

I say vainly imagine. For, it is a vulgar prejudice to suppose that a life spent in counting the number of segments and legs of bugs, and describing the microscopic foliation of their antennæ, incapacitates a man for comprehending the Mécanique Celeste, or the writings of Plotinus; for the enjoyment of the Mahabahrata, or the safe conduct of his hereditary estate What stamps the character of Le Conte as a genius is precisely

what gives the lie to this vulgar prejudice. He was as fine a mathematician as he was minutely true with the microscope. His wide and varied learning checked any tendency to narrowness in study, and gave him a power and richness of language which reacted on his reason to enrich it with a copious store of generous and noble ideas. The infinite variety of insect forms was not more attractive to him than the infinite variety of words in the languages which he studied ; nor the infinite variety of myths with which the imagination of past ages has attempted to explain, or at least to portray, the mysteries of the Universe. Will it excite surprise then in any well equipped mind, that the skill which nature gave him to arrange facts of the organic world, relationships of numbers, and the ideas of men, availed him quite as well in the leasing of his father's storehouses in New York, the reorganization of the wards of an army hospital, and the conduct of the business of the United States Mint ?

All this went together, and comes quite natural to a superior genius. It matters little what the man regarded as work, and what he regarded as play ; his work was creation and recreation in one, and his recreation was all good work. Every hobby a true genius mounts becomes under his management a trained war-horse or sagacious hunter. The contradictory occupations of such a man would be a reproach to less gifted mortals ; but in the career of such a man they are merely alternately diverging and converging careers of usefulness. The recognition of this truth by Major Le Conte was gratefully acknowledged by his son in narrating such anecdotes as the following :

Young Le Conte was put to school at St. Mary's College, in Georgetown, D. C. The discipline of the class-room was very strict. Everybody was kept to silent study ; none could leave his seat without command or permission. The Major visited the school to learn how John was getting on. The master said that he was good and diligent, but regretted to add that he was too much interested in a sort of knowledge which lay apart from his regular studies. He hoped that the father would endeavor to repress these inclinations in his boy. The Major asked the master what they were. The master replied—a love of birds and bugs, shells and stones, in fact, everything that grew, or moved in the air, on the ground, or in the water. If he indulged in such pursuits he would never excel as a mathematician or linguist. "Is my son behindhand then in his studies?" asked the father. "No," replied the master, "he recites well, and is as good a scholar as the best of them ; but we wish him to excel all the rest, as he evidently might do if he gave his undivided attention to the studies of his class."

"I am not of that opinion," quoth the Major, with the twinkle in his eye for which he was famous among his cronies—all now dead—"I am not at all of that opinion, and I must request that you will not discourage my son in obtaining a kind of knowledge which I have myself pursued all my life, and which I believe will make all the other kinds of learning which John will get here all the more useful and noble."

The good sense which prompted this request from the side of the father, prompted the master also to grant it, and thenceforward the young naturalist, while being subjected to the same rigid discipline, was not repressed in his inclinations for extra scholastic investigation, on a small scale.

One day silence reigned in the school-room. Everybody was conning his task at his seat. The tutor was silently reading at his desk. Suddenly there was a great fracas—John Le Conte was seen starting from his seat and scrambling on the floor in the middle of the room. He was called up to the tutor's desk to give an account of himself. He held in his hand two beetles. He explained that they were rare, that he could not help trying to catch them, that he had to be quick about it, that he did not know that he would make such a noise, etc. The other scholars in great excitement sat expecting dolorous consequences for John. But they were disappointed. The tutor remembered the Major. or perhaps had received orders from the upper region. He merely sent the boy back to his seat with his beetles, and a warning not to make so much noise another time.

But he received less mercy from his schoolmates. One holiday the boys were on an excursion in Frederick county. John captured two remarkably fine and rare coleopterids—I forget their name, but he always gave it when he told the story—and put them into a pill-box. At night two of his companions stole the box, threw the bugs away, neatly substituted two quids of tobacco, and returned the box to its place without detection. Great was John's grief at the discovery. But he never thought on any kind of revenge. He did not know enough Horace then to comfort himself with the barren consideration, that Quid quisque vitet nunquam homini satis cautum est in horas; but he thought it all the same, in a schoolboy's way, and learned by this experience to keep his shiny-backed pets out of the reach of profane fingers. Dr. Horn can best describe to us the care he took of his great collections.

Le Conte loved to tell such personal stories of his early life, and during the week preceding his death his mind lived entirely in those remote years. He laughed heartily to himself at the recollection of his adventures. He wished to have them published. Why? Was he vain? He was the reverse of vain; he was a man singularly free from vanity. Why should he have had so set a desire to be memorialized after death? I answer without a shade of hesitation, because he had inherited a loving disposition, had led an affectionate and sympathetic life, and wished above all things to retain forever his kind and good relations with his fellow-men. His love of his kind was strong. His sympathy with his fellow-workers in science was not only strong but unalloyed with baser sentiments. Even when his fine scorn of fraud, duplicity, pretension and untruthfulness evoked denunciation, I never knew him to depreciate any kind of talent. He was exceedingly just to just men, and generous towards those who had not had talents or opportunities sufficient to give them distinction. He honored the old and loved the young. He honored the masters and loved the students of science. He worshiped the shade of his father, and never spoke

of himself and his own attainments and accomplishments as anything more than an effort to follow in the footsteps of him who had given him the ability and opportunity to do so.

I dwell principally upon the moral qualities of our departed friend, because I trust that the Society will obtain a complete account of his scientific abilities from Dr. Horn, who has been first his pupil and then his collaborator for twenty odd years. Let us place on our records that memorial of a blameless career in science, and its application to the uses of human existence.

For myself I can only speak of what fills my heart to the exclusion of all other thoughts—of the lovable nature of the friend whom we shall never again see. Let the world reverence his memory as a discoverer, as a philosopher, as a genius. I can only remember John Le Conte as an engaging friend, a faithful friend, a speaker of the truth, a judicious adviser, a companion to think with, a reliable coadjutor to deal with, but still, above all, as a most affectionate and trustworthy friend.

I place above all his other exceptionally shining qualities his affectionateness. He was a lover; and all the world loves a lover. But good lovers are said to be good haters. I doubt the truth of the saying. Selfish lovers may be good haters, but the perfect lover is incapable of any hate that deserves the appellation. Le Conte was one of the men who liked to be called John. He had a regularly woman's heart. And yet he could not hate anybody. When he tried, he simply made himself ridiculous. I have often laughed at his wrath ; it would no more counterfeit real hatred than a crystal of smoky quartz can counterfeit charcoal. His innate lucidity of good nature could not be veiled ; it was as if a cherub knit its brows. And this innate good nature, allying him with the universe, was the salvation of his science, for it protected his mind against those damaging and delaying passions which futilize the career of men of talent, hough their horses and steal the linchpins from their chariot-wheels.

Lovingly he lived and worked many, many years—as many as were good for him. The world wants us all ; and yet needs none of us. It is of no great consequence who is who, or what or how much any one does. What one leaves another takes ; what one begins, some one else is sure to finish. But surely the memory of a friend is blessed, and such a friend as has just left us can never be forgotten.

Memoir of John L. LeConte, M.D. By George H. Horn, M.D.

(*Read before the American Philosophical Society, December 7, 1883.*)

John Lawrence LeConte was born in New York City, May 13, 1825, and died in Philadelphia, November 15, 1883. He was the son of Major John Eatton LeConte and Mary A. H. Lawrence. When but a few weeks old his mother died, and the father thenceforth seemed to live solely for the

care and development of his only child. The devotion of the father was rewarded in living to see the son take a foremost place among the scientists of his day, honored at home and abroad. The father had already made the name well known in science, when the son entered the field and added greatly to its renown.

After arriving at a suitable age, the boy was placed in St. Mary's College, Maryland, from which he graduated in 1842. From the Doctor's account the discipline of the school was severe, the training accurate and thorough, and the tutors conscientious in the discharge of their duties. At this early period of his life he exhibited the tastes of a naturalist, and he has often recounted the annoyances and ridicule to which he was subjected by his fellow-pupils, who had no sympathy with his pursuits. His teachers, even, feared that his, to them, more important studies would be neglected, and the father was made acquainted with their suspicions. Finding that the pupil was in no respect deficient in his regular duties, the father directed that these tendencies should not be repressed. The boy made rapid progress, and exhibited a peculiar aptitude for the study of languages and mathematics, and, doubtless, in this manner laid the foundation for that accuracy and retentiveness of his memory so characteristic of his maturer years.

After the completion of the collegiate course, he returned to New York, and entered the College of Physicians and Surgeons, receiving his medical degree in 1846. Before this date his first essays in original work made their appearance, and, to use his own language, gave unmistakable evidence of his youth and inexperience.

During 1849 he made several visits to the upper shore of Lake Superior, collecting largely, and publishing the results, with many new species, in Agassiz's work on that region. In the autumn of 1850 he visited California, stopping for a short time at Panama, remaining absent during the greater portion of the following year. His explorations in California were made, for the most part, south of San Francisco, at San José, San Diego and their surroundings. From the latter point he crossed the Colorado desert, then and for many years after a terror to travelers, going as far eastward as the Pima villages. The entire region was a new one to science, and he made abundant use of his opportunities. On his return the results of his journey were published in the "Annals of the Lyceum" of New York. The new material was, however, so abundant that some yet remains in his cabinet unstudied.

In 1852 the LeContes removed to Philadelphia, and the works of both have, with few exceptions, been published in the periodicals of our societies since that time.

For a few months in 1857 he accompanied the Honduras Inter-Oceanic Survey, under the command of the late John C. Trautwine, publishing his observations in that region in the report of the survey. At the same time he visited the Fuente de Sangre, publishing his account of that phenomenon in Squier's Nicaragua.

After these voyages, his scientific studies were uninterrupted until the early years of the war, when he was appointed surgeon of volunteers, and shortly after medical inspector, with the rank of Lieut.-Colonel, in which he showed that his capability for direction and organization was adaptable to wider uses than the cabinet to which he had hitherto confined himself.

During the summer of 1867 he accompanied General W. W. Wright on the survey for the extension of the Union Pacific Railway southward to Fort Craig, in the capacity of geologist. His report, which in no way detracts from his reputation as an entomologist, was published as part of the report of the survey.

In the autumn of 1869 he determined on a visit to Europe, in which he was accompanied by his family, remaining abroad until near the close of 1872, visiting also Algiers and Egypt. His residence abroad interrupted somewhat his authorship, but not his studies, and his letters to me, now doubly valuable, gave abundant evidence of his activity. He visited all the accessible public and private museums, and his wonderful memory of the species in his own cabinet enabled him to settle many hitherto doubtful points of synonymy. Those who met him abroad were deeply impressed by his thorough scholarship, and his quick and accurate perception of the affinities of insects never before seen by him. On his return to Philadelphia his work continued, with but slight interruptions by periods of sickness, until within a week of his death.

The lives of men eminent in science are rarely fertile in events of general interest, and LeConte's is no exception. Trained from his boyhood as a naturalist, with no cares, and no interruptions by daily professional or business duties, his life was passed in the pursuit of his favorite studies and the pleasures of social life. The father died in 1860, leaving the son in possession of an ample estate. The following year Dr. LeConte married Helen, daughter of the late Judge Robert C. Grier, who, with two sons, survives her husband.

The account of the life in science of LeConte should properly begin with that of the father—the one is the result and continuation of the other. An abler pen than mine has already traced the life of the elder LeConte, and I merely purpose to recall such incidents in his life as seem to have a bearing in determining the subsequent studies of the son.

Major LeConte contributed a short entomological paper to the "Annals of the Lyceum," of New York, as early as 1824, describing a few new species, illustrated by a plate drawn by himself. At this time Say and the elder Melsheimer were at the height of their career, and entomology, through the labors of Latrielle in France, was assuming a higher position among the sciences. The Major was an ardent collector, and, desiring the light not attainable at home, much of his material was sent abroad; he, however, retained either carefully compared specimens or drawings to permit the future identification of the species. The cabinet thus formed, small in comparison with what we now have, made the basis of the subsequent work of the son. In 1845 the father and son contributed entomological

papers to the Boston "Journal of Natural History," the former a monograph of Histeridæ, the drawings for which were made by the son, the latter a small paper of little moment.

The first paper by Dr. LeConte appeared in 1844, in the "Proceedings of the Academy of Natural Sciences," having been transmitted by the Entomological Society of Pennsylvania, an association with no permanent locality, consisting of, probably, not more than a half score of enthusiasts, who met at long intervals at the house of one or another. Among the number we find the two Melsheimers, Ziegler and Haldeman, while the Rev. J. G. Morris, D.D., of Baltimore, alone survives to recount their history.

The early papers by LeConte gave very little evidence of his analytical power until, in 1850, he published his "Monograph of Pselaphidæ," proposing an arrangement which remains at present the basis of the general classification of these minute insects. In the same year appeared the commencement of his "Attempt to Classify the Longicorn Coleoptera of America north of Mexico," requiring several years in publication, a work of much wider application than indicated by its title, contributing much that was new to science, and aiding greatly in the rational classification of these favorite beetles.

From this period his contributions to entomology were for the most part monographic, and from their importance soon attracted attention abroad, many of them being reprinted in foreign journals, winning for their author the reputation he justly deserved. In their scope his papers cover nearly every portion of his specialty. They contain evidences of patient and original research, and added greatly to science. His work was in every case an improvement on what had previously been done; he left a subject better than he found it.

Several of his works call for special mention. In 1859 he collected the entomological works of Say, with notes on the species described. In this he was assisted in their specialties by Baron Osten-Sacken and Mr. P. R. Uhler. The writings of Say were widely scattered in almost inaccessible publications, his typical collection almost entirely destroyed, and the species depended practically on traditional knowledge; and while some of Say's cotemporaries were yet living LeConte gathered the information possessed by them, and placed it in permanent form.

Realizing that his specialty needed greater assistance, he undertook, at the request of the Smithsonian Institution, the "Classification of the Coleoptera of North America," with the "List of Species." and descriptions of new ones. The first parts appeared in 1861 and 1862; its continuation was interrupted by the war and his absence abroad. It was resumed in 1873, but never completed. The assistance thus given to students vastly increased their number, and the limited edition soon became exhausted, and it became necessary to decide either for a reprint or a new book.

Before a new edition could be completed, it became imperative to study the Rhynchophora, and at this point LeConte made one of the boldest strokes of his career in the isolation of that series, and purposing a classi-

fication as remarkable in novelty as it was true to nature This was followed in 1876 by the "Species of Rhynchophora," published as a separate volume of the Proceedings of our Society.

The preliminary studies having been completed, LeConte's desires seemed to be concentrated in the preparation of a new "classification," which should be complete in all its parts He invited my coöperation in the preparation of monographic essays, hoping thereby to lighten his own labor, and prepare the work in a shorter time. Two years ago, when he realized that his health was failing, he expressed the desire that I should join him in more active authorship in the work The first pages went to press in January, 1882, and the book was completed in March of this year, in time for him to realize that it has been, at least, well received. For obvious reasons I cannot dwell upon the merits even of his share of this work, except to say that his earlier edition is the basis of the present, without the former the latter might not have appeared. Evidences of his influence will be found on every page, and whatever it was my privilege to contribute was made possible entirely by his early instruction and guidance

Since last spring he has done but little study, his general health, uncertain vision and unsteady hand having unfitted him for close application. He, however, continued work in the form of "short studies," until within a few days of his death, and the incomplete manuscript now in my hands will appear in the form in which he desired to present it.

While LeConte's reputation as a naturalist will rest upon his entomological writings, he did not limit himself to this field. Mention has already been made of several important geological contributions; there are others of less moment. He has contributed a number of articles on Vertebrate Paleontology, and several synopses of some genera of rodents His "Zoological Notes of a Visit to Panama," illustrate the extent of his study in another department of science. At least one article on purely social science, has emanated from his pen.

In a general review of LeConte's writings, we find them remarkably free from controversial tendencies. He gave to science the results of careful study, knowing that in time whatever was worthy would be adopted. His dissent from the views of another was always couched in the mildest terms. He was above the limit of those petty jealousies which too often prevail between those working in the same field.

Numerous were the demands for his advice and assistance from all parts of the country; rarely did he repel them, and no small portion of his time was consumed in the determination of specimens for correspondents, with no other reward than the hope that the seed thus sown might some day bear fruit.

The results of LeConte's works in Coleopterology in America are plainly marked. He entered the field ten years after the death of Say, who seems to have had no higher ambition, if indeed capacity, than the description of the species which he collected. LeConte, on the other hand, began the

framework of a systematic structure which he lived to see completed in all its parts. He reduced chaos to order. His influence in entomological progress in general is admitted on all hands, and so rapid has been the advance that we now have nearly as many purely entomological societies and clubs as there were interested individuals forty years ago. At that time the American literature consisted of very little beyond the works of Say; to-day five periodicals are devoted solely to entomology.

Some idea of the actual work performed by LeConte may be obtained from a summary recently published, in which more than five hundred genera and nearly five thousand species are placed to his credit, three-fourths in each series remaining valid. It would, however, be unfair to estimate the value of his work from a mere numerical basis; others have done much more, but the systematic, analytical studies, spread over the vast field of Coleopterology, show the real power of his mind. While he was quick to perceive specific differences, he was not always happy in expressing them; in his analyses his reasoning was always clear without the slightest ambiguity.

That his work has been appreciated at home and abroad is shown by the number of societies which have elected him to membership. Diplomas from fifteen American and seventeen European societies may be seen in his portfolio. Prominent among them are the diplomas of honorary membership in the entomological societies of London, France, Berlin, Brussels and Stettin, an honor rarely conferred and given only to the most worthy.

In 1874 LeConte was elected President of the American Association for the Advancement of Science, and his address on retiring, regarding the relation of the geographical distribution of Coleoptera to Paleontology, opened a new line of investigation, showing how a combination of the facts of two such dissimilar sciences might result in advantage to both.

He was one of the founders of the American Entomological Society, and at the time of his death its President; of our own Society he was a Vice-President, and has been a member nearly thirty-one years.

We all knew him as a cultured scholar, a refined gentleman, a genial companion, a true friend. To me he was more. For nearly twenty-five years our association has been of the most intimate nature. I sought his advice and instruction as a neophyte in entomology, finding a welcome which I had no reason to except. Our friendship ripened to an intimacy never shadowed by the slightest cloud. My last visit to him, two days before his fatal attack, will never be forgotten; bright, cheerful and much clearer in mind than he had been for weeks before, he seemed to have regained his mental and bodily strength, and gave me strong hopes that we might for some time enjoy his society. When called to his bedside two days after, the change from brilliant intellection to death-portending coma was almost too great to realize. His life closed painlessly, without a struggle. A few short hours sufficed to extinguish a bright light in science, and inflict on us an irreparable loss.

Dr. Horn testified to the scientific ability, activity and reputation of Dr. LeConte; and Mr. Fraley to his personal worth.

On motion of Mr. Eli K. Price, Dr. Horn was appointed to prepare an obituary notice of Dr. LeConte, and accepted the appointment.

Dr. Brinton reported his reception as delegate of the Society to the Congress of Americanists at Copenhagen, and described the proceedings.

Mr. Phillips, the other delegate, explained that he had been unable to attend the Congress.

General Thayer described the trial balloon which he is building, and explained the principles involved in the problem of of aerial navigation. (See 301.)

Professor Cope described the geological formation and fossil wealth of the valleys and mountains of New Mexico, traversed by him during his recent explorations.

Pending nominations Nos. 985 to 1008 and new nominations Nos. 1009 and 1010 were read.

The minutes of the last meeting of the Board of Officers and members in Council were read.

The Committee of Five reported the following resolution, which was adopted:

Resolved, That hereafter at the stated elections for members of the Society, the presiding member shall appoint two tellers to open the ballot-boxes, and report to him the result of the poll.

On motion of Mr. Law, the following was adopted:

Resolved, That Dr. Brinton be authorized to translate and prepare for publication the Kakchiquil Grammar now in the archives of the Society, and that the same be published in the Proceedings in such type as the Secretary may deem best suited to the purpose.

Mr. Phillips noticed an ambiguity in Sec. 3, Chap. I, of the By-Laws, and Mr. Fraley recounted the traditional interpretation of it by the Society.

The meeting was then adjourned.

Aerial Ships. By Russell Thayer, C.E.

(Read before the American Philosophical Society, Nov. 16, 1883.)

At the close of an interesting paper on the subject of aerial navigation, read before the Institution of Civil Engineers, by Mr. William Pole, F.R.S. M. Inst. C. E., the following conclusions are stated, viz.:

"The problem of aerial navigation by balloons is one as perfectly amenable to mechanical investigation as that of aquatic navigation by floating vessels; and its successful solution involves nothing unreasonable or inconsistent with the teachings of mechanical science.

"It has been fully established by experiment that it is possible to design and construct a balloon which shall possess the conditions necessary for aerial navigation, *i.e.*, which shall have a form of small resistance, shall be stable and easy to manage, and, if driven through the air, shall be capable of steering by a proper obedience to the rudder.

"If, by a power carried with the balloon, surfaces of sufficient area can be made to act against the surrounding air, the reaction will propel the balloon through the air in an opposite direction.

"The modern invention of the screw-propeller furnishes a means of applying power in this way, to effect the propulsion; and the suitability and efficacy of such means have been shown by actual trial.

"Sufficient data exists to enable an approximate estimate to be made of the power necessary to propel such a balloon with any given velocity through the air.

"The recent great reduction in the weight of steam motors has rendered it possible to carry with the balloon an amount of power sufficient to produce moderately high speed, say twenty or thirty miles an hour through the air; and by taking advantage of other recent improvements it would also be possible to carry a moderate supply of fuel and water for the working.

"The practical difficulties in the way are only such as naturally arise in the extension of former successful trials, and such as may reasonably be expected to give way before skill and experience."

In the discussion of the question, Mr. Pole considered the propeller as being the only known available means of utilizing the force generated for the propulsion of the aerial ship; and the deductions above quoted are based upon this means being used to apply the force. My investigations and experiments, however, have induced me to believe that for the purpose desired the propeller is a most clumsy and unsuitable contrivance; indeed, the immense size that would be required for the propulsion of even aerial ships of ordinary dimensions renders its use impracticable.

For the past year I have been making somewhat of a study of this subject, with the object in view of ascertaining whether any practicable method of propulsion could be devised which would enable an aerial ship properly constructed to have a rapid motion through the air, in any direction, entirely independent of the atmosphere or medium in which it floats.

An investigation of the methods heretofore devised to accomplish this object, viz., wheels, propellers, wings, etc., convinced me that all plans so far suggested are quite impracticable; and my experiments led me to the following discovery, based on the well-known law of mechanics that "action and re-action are always equal, contrary and simultaneous."

My invention is simply to make use of the reactive force of a powerful jet of air, gas or vapor, acting rearwards under pressure; thus producing* a re-action forward equal in every respect to the pressure backwards. Under these circumstances the aerial ship will be forced forward at rates of speed depending upon the amount of pressure applied, and it is surprising to note the small pressure required to send a structure of considerable size through the atmosphere at rates of speed varying from ten to fifty miles an hour, without the assistance of the wind, which, under some circumstances, could be most beneficially employed in generating very high rates of motion.

For the following formulæ and values of co-efficients below mentioned, I am indebted to Mr. Pole's paper above referred to; and I have condensed my ideas on the subject in the following memorandum of notes, giving all the salient points of the problem:

Shape.

d = diameter midship section.

e = length of axis.

Shape, cylindrical, pointed at both ends (fore and aft), the best form wherein $e = 3\frac{2}{3}d$.

Ascending Force of Gas.

Ad^3l, in which A is a co-efficient, depending on the shape of the vessel and on the specific quantity of the gas compared with that of the surrounding air, may be taken = .03.

The levity of 1 cu. ft. of hydrogen = .0751 lb.

Resistance to Motion through the Air.

$x = .000193\ d^2 v^2$, in which v = velocity in feet per second. The resistance varies as the square of v.

Propelling Force.

The propelling force should act in a horizontal line with all the resistances, which would be a little below the line of the axis (Pole). This force would be produced by air, gas or vapor, acting sternwards under pressure; preferably compressed air, forced through a nozzle suitably connected with a high speed air-compressor.

Machinery Required.

Boiler, steam-engine, air-compressor (receiver), outlet-pipe with nozzle steam condenser, with chemical refrigerating mixture.

* Genl. Thayer has taken out patents for this invention.

To Raise and Lower Ship without using Ballast.

Use an interior air-vessel connected with air-pump, the exterior balloon being connected with a strong light receiver containing hydrogen gas under high pressure. To lower ship, pump air into interior sack and remove hydrogen from exterior balloon. To ascend, remove the air from the interior sack and allow hydrogen to flow into balloon under pressure from receiver; the hydrogen in the receiver would also be utilized to supply loss from leakage.

To Steer Ship.

Use rudder and also a movable nozzle, through which the force of propulsion is applied.

To Elevate or Depress Bow.

Shift ballast or elevate or depress nozzle.

Miscellaneous Data.

In landing, turn the head of the aerial ship to the wind, thus avoiding all danger from dragging, etc. In navigating, it is only necessary to go high enough to clear terrestrial objects.

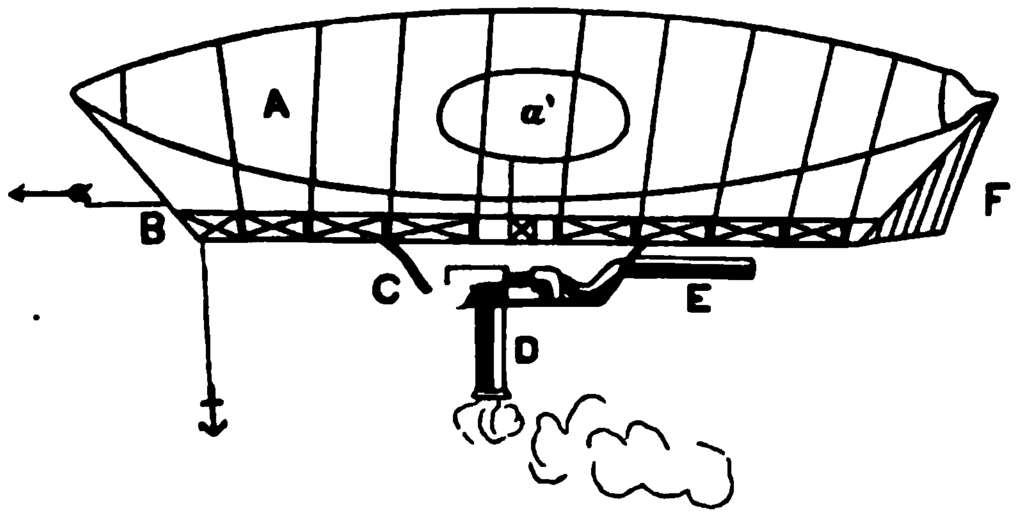
Weight of motor, 40 lbs. per H. P., loss about 15 per cent.

Fuel, 4 lbs. per indicated H. P. per hour.

Water, 28 lbs. per H. P. (condense the steam).

Giffard made envelopes successfully to contain gas with scarcely any loss.

In conclusion, I would say that the general appearance of the aerial ship would be as follows, viz.:



A, balloon; B, upper deck; C, lower deck for machinery; D, smoke-stack; E, nozzle; F, rudder; a′, interior air-sack.

Example.

$\left.\begin{array}{l} d = 30' \\ l = 110' \end{array}\right\}$ Total ascending force $Ad^2l = 2970$ lbs.

Resistance to passing through the air at a speed of twenty miles an hour = 29.33 lin. feet per sec., $000193\ d^2\ v^2 = 149.5$ lbs.,

a force that can readily be obtained and applied, as I have suggested.

Detailed Section of Chemung Rocks Exposed in the Gulf Brook Gorge a
Roy, Bradford County, Pennsylvania. By A. T. Lilley, of Le Roy.

(Read before the American Philosophical Society, December 7, 1883.)

		Feet.
1.	Cap of Chemung with *Atrypas* and many unrecognizable forms in light shale. (*Spirorbis* among them)	1
2.	*Productella* bed in gray sand	10
3.	Green shale	15
4.	Red shale	4
5.	Green shale	20
6.	*Grammysia* bed and gray shale	25
7.	Iron ore, with *Spirifer, Pterinea, Crinoids, Grammysia*, and *fish remains*. (*Spirorbis* among them)	4
8.	Green shale	20
9.	Red *fucoid* bed	8
10.	Green sandstone	20
11.	Red shale and sand with unrecognizable fossils	4
12.	Conglomerate with pebbles, lime, *Spirifer, Productella* and *fish* remains	6
13.	Green shale	10
14.	Pink shale	2
15.	Green shale	40
16.	Green sandstone	2
17.	Gray sandstone	19
18.	Gray sandstone	1
19.	Green shale	52
20.	*Strophomena bed*	1
21.	Green sandstone	14
22.	Green shale	40
23.	Brown sandstone, with *Spirifer* and *Productella*	1
24.	Gray sandstone, with *Crinoids* and *plants*	8
25.	Green shale	6
26.	Green sandstone and shale, with *Crinoids* and *Spirifers*	8
27.	Gray sandstone and shale	60
28.	Green sandstone, with *shells* and *fish remains*	53
29.	Red shale and sandstone	14
30.	Brown sandstone, with *shells* and *fish remains*	39
31.	Green shale	6
32.	Red sandstone, with *iron ore* and *shells*	8
33.	Gray shale	8
34.	*Calcareous iron ore* and sandstone	12
35.	Brown shale	20
36.	*Calcareous iron ore* (red) and sandstone	11

	Feet.
37. Gray sandstone and shale with carbonized *plant stems*, sulphate of iron and *shells*	2
38. Brown sandstone, with *shells*	10
39. Brownish sandstone, with *Spirorbis* and *shells*	35
40. *Crinoidal limestone*	4
41. Bluish shale	8
42. *Calcareous red sandstone*	9
43. Brown sandstone	18
44. Green sandstone	8
45. *Calcareous sandstone*	4
46. Green sandstone and shale	90
47. *Calcareous sandstone*	5
48. Light gray sandstone and shale	130
49. Gray shale	63
50. *Conglomerate*, with *shells*	3
51. Green shale	12
52. Green sandstone and shale	270
53. *Limestone*, with *shells*	2
54. Gray sandstone and shale, with *shells*	220
55. Gray sandstone, with *fucoids*	1
56. Green sandstone	42
57. Blackish shale, with *Lepidodendra*	50
58. Green and brown sandstone and shale	100
59. Green shale	25
60. *Upper Ambocœlia bed*, with *Loxonema*, *Spirifer*, *Grammysia* and *Bellerophon*	2
61. Unexposed for	70
62. *Lower Ambocœlia bed* in green shale of	50
63. Unexposed to line of Granville township, Bradford county, Pa	50
	1855

Mr. Lilley has made extensive collections of fossils from these rocks, me of which have been studied by Prof. Claypole, of the Second Geo-gical Survey. Recently he has added largely to his number of fish from e Chemung and Lower Catskill rocks ; some of the forms seem new.

The Upper Mansfield red beds occasionally contain vast numbers of e plates and scales of fish large and small ; he has one perfect scale that easures more than four inches across.

Mr. Lilley has found *Spirorbis* in Nos. 1, 7 and 39 of the section ; that at intervals of 74′ and 540′ respectively.

He has found a *Holoptychius scale* marked on a rock which contains *ten-culites*, *spirifer*, *ambocœlia*, *pterinea*, and numerous minute shells the ecies of which he cannot recognize, in the Gulf Brook among the débris the Mansfield red beds. The rock resembles that of one of the Mansfield ed beds outcropping in a small gorge a quarter of a mile west of Gulf rook, and containing also *tentaculites*, an *orthoceras*, *fish bones*, *crinoids*, nd concretionary balls about the size of mustard seed.

Stated Meeting, December 7, 1883.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

The resignation of Judge Thayer was received and accepted.

Letters of acknowledgment were read from the Astor Library (XVI, i), the Franklin Institute (XVI, i), the American Statistical Association (113) and the American Ethnological Society (113).

Letters of envoy were received from the Natural History Society at Chemnitz; the Second Geological Survey of Pennsylvania; the Society of Natural Science, at Poughkeepsie; the United States Geological Survey, and Prof. J. J. Stevenson, of the University of the City of New York.

A letter from the S. N. M. S., at Cherbourg, was read, requesting numbers of Proceedings of American Philosophical Society to complete a set.

A letter of inquiry was received from W. F. E. Gurley, dated Danville, Ill., Nov. 30, 1883.

Donations for the Library were reported from Mr. B. S. Lyman, late Chief Geologist of Japan; the German Geological Society; the Anthropological Societies at Vienna and Paris; the Natural History Society at Chemnitz; the Royal Academy at Brussels, and Prof. Paul Albrecht; the Musée Guimet; the Revista Euskara and Revue Politique; the Commercial Geographical Society at Bordeaux; M. Claudio Jannet, of Paris; the Annales des Mines; the Royal Astronomical Society and London Nature; the editor of Cosmos; the Canadian Institute; Littlefield, bookseller, of Boston; the Bunker Hill Monument Association (Hon. R. C. Winthrop); the Boston Natural History Society; Cambridge Museum of Comparative Zoölogy; Harvard University; Essex Institute; American Journal of Science, New Haven; Meteorological Observatory, New York; Vassar Brothers' Institute; Franklin Institute; Dr. D. G. Brin-

ton; American Journal of Pharmacy; Mr. Herbert Welsh; Mr. H. Phillips, Jr.; the Secretary of the Geological Survey of Pennsylvania; the United States Naval Institute; United States Fish and Education Commissioners; United States Geological Survey (C. E. Dutton); H. L. Abbot; S. W. Rauck, of Lexington, Ky.; and the Old Charter of the Hudson's Bay Company, with Arthusen's description, De Boy's and Le France's maps from Prof. J. J. Stevenson.

Dr. Horn read an obituary notice of the late Vice-President, Dr. John L. Le Conte. (See page 294.)

The death of Dr. Charles W. Siemens, at London, Nov. 20, aged sixty-three, was announced by the Secretary.

A section of 1856 feet of Chemung rock at Gulf Brook, Le Roy, Bradford county, Pa., by Mr. Lilley, was read by Mr. Lesley. (See page 304.)

Prof. Cope communicated the following papers:

1. On the distribution of the Loup Fork formation in New Mexico. (See page 308.)

2. A second addition to the knowledge of the Fauna of the Puerco Epoch. (See page 309.)

3. On the Trituberculate type of molar tooth in the Mammalia. (See page 324.)

The Synchronous Multiplex Telegraph invented by Mr. Patrick B. Delaney, of New York, was described by Prof. Houston. (See page 326.)

The Treasurer's annual report was presented.

Pending nominations Nos. 985 to 1010, and new nomination No. 1011 were read.

The Curators were instructed to obtain expert advice from some member of the Society as to the better preservation of the portraits in oil of former officers of the Society.

And the meeting was adjourned.

On the distribution of the Loup Fork formation in New Mexico. By E. D. Cope.

(Read before the American Philosophical Society, December 7, 1883.)

In his report on the Geology of New Mexico to the Secretary of the Interior by Dr. . V. Hayden, in 1869, this eminent geologist described the Santa Fé marls in their principal physical features. In 1874, in my report to Capt. George M. Wheeler, U. S. Engineers, I showed that this formation is a member of the Loup Fork division of the Miocene Tertiary, a conclusion clearly deducible from the remains of vertebrata which it contains. An illustrated report on the latter was published in the fourth volume of the report of the United States Geographical and Geological Survey, W. of the 100th meridian, Capt. G. M. Wheeler in charge (1877).

Since that time the writer has made several visits to part of New Mexico not previously explored, and I am able to show that the Loup Fork formation has a much wider distribution in that Territory than has hitherto been supposed to be the case.

In descending the Rio Grande, beds appear on the west side of the river which strongly resemble those of Santa Fé. They extend along the eastern base of the Magdalene mountains, and as far south as Socorro, in considerable extent and thickness. South of Socorro they appear, but less extensively. The eastern part of the plain which lies between the Rio Grande and the Mimbres mountains is composed of beds of this age where cut by the grade of the Atchison, Topeka and Santa Fé railroad, west of Hatch station. West of the Mimbres mountains the valley of the river of the same name is filled with débris of the bed of eruptive outflow which once covered the country, as far as traversed by the railroad from Deming to Silver City. Its age I could not ascertain.

A great display of the Loup Fork formation is seen in the drainage basins of the heads of the Gila river. In traveling westward from Silver City, its beds first appear in the valley of Mangus creek, which enters the Gila from the east. Crossing the Gila, the mail route to the west passes through the valley of Duck creek, which flows eastwards into that river. Though bounded by eruptive hills and mountains and their outflows, the valley was once filled with Loup Fork beds, which have been extensively eroded, the principal exposures being on the north side of the valley, forming the foot-hills of the Mogollon range. On the divide between the waters of the Gila and San Francisco rivers the formation rises in bluffs of 300 feet elevation. The descent into the valley of the San Francisco brings to light a still greater depth of this deposit. The valley which extends from the cañon which encloses the river south from the mouth of Dry creek to the Tulerosa mountains on the north, and between the Mogollons on the east and the San Francisco range on the west, was once filled with the deposit of a Loup Fork lake. This mass has been reduced by the erosive action of the San Francisco and its drainage, to a greater or less

extent, as it has been protected by basaltic outflows or not. When so protected, the river flows through comparatively narrow cañons. Where the outflow is wanting, the valley of the river is wider, and the Loup Fork formation remains as wide grassy mesas which extend to the feet of the mountain ranges.

The age of these beds would have remained problematical but for the fortunate discovery by Mr. Robert Seip, of the skull of a species of Rhinoceros of the typical Loup Fork genus, Aphelops. It is apparently the *A. fossiger* Cope, a species abundant in the Loup Fork beds of Kansas and Nebraska. It was found near the mouth of Dry creek in a conglomerate bed of the formation.

In the valley of the San Francisco the Loup Fork beds reach a thickness of 500 feet, and consist of sand, clayey sand, soft sandstone, and conglomerates of larger and smaller pebbles of eruptive material, having a near resemblance to those of the region of Santa Fé.

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*Second Addition to the Knowledge of the Puerco Epoch. By E. D. Cope.**

(Read before the American Philosophical Society, December 7, 1883.)

Recent collections from the formation above-named, include many finer specimens than have been previously obtained. Skulls of several species in calcareous concretions were received, so that their characters can be developed more fully than heretofore. I mention especially *Deltatherium fundaminis*; *Periptychus rhabdodon* and *P. coarctatus*; *Haploconus lineatus*; *H. entoconus*; *Anisonchus sectorius*; *Protogonia plicifera*; *Mioclænus turgidus*, *M. ferox*, *M. subtrigonus* and *M. cuspidatus*, sp. nov. Some species hitherto rarely seen, prove to be abundant, as *Hemithlæus kowalevskianus*, *Protogonia plicifera*, *Mioclænus minimus* and *M. subtrigonus*. With the additional species now described, the number of Mammalia from the deposit of the Puerco epoch amounts to seventy-four species.

DIDYMICTIS PRIMUS, sp. nov.

That the genus Didymictis existed during the Puerco epoch, has been already demonstrated by the discovery of the *D. haydenianus* Cope. This species is of aberrant form however, so that it remained to prove that the typical form had appeared so early in Tertiary time. This is now shown to have been the case by the discovery of the present animal, which is allied to the *D. leptomylus* of the Wind River and Wasatch epochs.

The *Didymictis primus* is known from two maxillary bones with teeth,

*The "First Addition" appeared in the Proceedings of the American Philosophical Society for 1883, beginning at page 545. Since that date I have described in the Proceedings of the Philadelphia Academy, 1883, p. 168, the following species: *Periptychus coarctatus*, *Pantolambda cavirictus*, *Zetodon gracilis* (g. n.) and *Conoryctes ditrigonus*.

and a part of a mandibular bone with the last two molars in place, all belonging to different individuals. The inferior sectorial tooth is much like that of the *D. leptomylus*, but the tubercular is only two-thirds as long, and is not only absolutely, but relatively narrower posteriorly. It has the usual three cusps in a reduced condition. In the first superior true molar the external cusps are conical, and there is a small cusp between the anterior one and the produced anterior angle of the crown. There is an anterior intermediate tubercle, but no posterior one. The cingulum does not extend all round the inferior base of the crown, as it does in *D. protenus*. The sectorial has a distinct anterior basal conic lobe. The internal lobe is in transverse line with the last named, and is conical and not large.

Measurements.		M.
Diameter inferior sectorial	anteroposterior	.0138
	transverse	.0055
Diameter inferior tubercular	anteroposterior	.0050
	transverse	.0038
Depth of ramus at M. i		.0098
Diameter superior sectorial (No. 1)	anteroposterior	.0110
	transverse	.0060
Diameters superior sectorial (No. 2)	anteroposterior	0050
	transverse	.0090

The fourth specimen is especially important as presenting almost the entire dentition including canines and incisors, and the anterior part of the skull from the line of the coronoid process of the mandible. The specimen shows that the species differs from the species of the Wasatch period with oval inferior tubercular, in the absence of the posterior cutting lobe of the third, and probably fourth inferior premolar. The corresponding superior premolars are also simple. The first premolars in both jaws are one-rooted. The canines are long and acute, and are directed vertically. Both have flat facets on their external (the only visible) faces: on the superior canine I count four lateral, and one nearly anterior. On the inferior I see three lateral and one nearly anterior. There are three small superior incisors, of which the first is the largest, and has a subconical crown. The infraorbital foramen is large, and is above the anterior border of the superior sectorial.

Measurements.	M.
Length of superior dental series to front of canine	.041
" " crown of superior canine	011
" " superior true molars	.0105
Depth of ramus at inferior sectorial	.0090

In its simple premolars this species agrees with the *D. haydenianus*, and is more primitive than the Wasatch species.

TRIISODON RUSTICUS, sp. nov.

Founded on a portion of the mandible which supports the first two true molars and part of the last premolar. The species is of the type of *T.*

levisanus, but is much larger. I give here a synopsis of the species of the genus, so that its affinities may be better understood. In general, the genus *Triïsodon* is characterized by the rudimental character in the inferior molars of the anterior cusp. It is thus like *Ictops*, but differs in having the fourth premolar different from the true molars and like the premolars. From *Mioclænus* it differs in having the anterior and posterior cusps of the inferior molars unequal; the anterior forming together an elevated crest with two apices, while the posterior are low, and on the borders of a heel.

I. Cusps of inferior molars compressed.

Anterior cusp very low.................................. *T. quivirensis.*

II. Cusps of inferior molars not compressed.

Anterior cusp very low; *T. rusticus; T. levisanus*, and *T. assurgens.*

Anterior cusp as high as other anterior cusps to which it is closely united.

T. conidens and *T. heilprinianus.*

In dimensions the *T. rusticus* is about equal to the *T. quivirensis*, thus exceeding the other species excepting the *T. conidens*. The interior anterior cusp is nearly as elevated as the exterior, and is united with it nearly to the apex; the anterior cusp is a tubercle which projects forwards from its anterior base. The heel of the tooth is wide, and is rounded posteriorly, and supports three tubercles, an external, a posterior and an internal, all in contact with each other. On the second true molar the internal anterior tubercle presents a slightly projecting edge anteriorly and posteriorly, which bounds a shallow vertical groove of the mass which represents their united bodies. This is not apparent in the first. The enamel is smooth, but the animal is rather old.

	Measurements.		M.
Diameters of m. i	anteroposterior		.0123
	transverse		.0068
	vertical	in front	.0068
		at heel	.0038
Diameters of m. ii	anteroposterior		.0137
	transverse		.007
	vertical	anteriorly	.007
		at heel	.0062

D. Baldwin, discoverer.

TRIÏSODON ASSURGENS, sp. nov.

This is the least species of the genus, and resembles in its inferior dentition the species of *Diacodon*. It is very much larger than the *D. alticuspis*, the larger species of that genus, which is found in the Wasatch formation.

The *T. assurgens* is known from a mandibular ramus which supports the last four molars, the last premolar having lost its principal cusp. The peculiarity of the true molars is seen in their generally more produced character; the anterior cusps are higher and the heels are longer. The anterior cusp is very small and basal; the principal anterior cusps are united

to near their free summits. There are the usual low marginal tubercles on the heels. That of the fourth premolar is a short simple edge.

Measurements.	M.
Length of four molars on basis	.028
" " three true molars	.0212
" " second true molar	.008
Elevation of cusps of molars	.0045
Length of last true molar	.0067
Width of last true molar	.0030
Elevation of last true molar in front	.0035

Found by D. Baldwin.

MIOCLÆNUS CUSPIDATUS, sp. nov.

The species of this genus known to me are, with the present one, nine in number. They range in size from that of a rat (*M. minimus*) to that of a wolf (*M. ferox*). The general osteological characters of the last named species are best known, and are described in the Proceedings of the American Philosophical Society, 1883, p. 547. In two of the species the superior dental series only is more or less known, and one species rests on mandibular dentition only. In the remaining seven species the dentition of both jaws is more or less known. The species may be arranged in groups as follows:

I. The posterior heel of the second inferior molar bordered by a curved edge or crest.

a. Posterior cingulum of superior true molars obsolete; *M. minimus.*

aa. Posterior superior cingulum weak; *M. turgidus.*

aaa. Posterior superior cingulum large, angulate; *M. corrugatus*; *M. ferox.*

II. The posterior heel of the second inferior molar supporting a cusp.

a. Posterior inner cusp of superior molars small, present on m. ii only; *M. cuspidatus.*

aa. Posterior inner cusp large, present on m. i and m. ii; premolars small, *M. subtrigonus*; premolars large, *M. opisthacus* (*Hemithlæus mihi olim*).

III. Second lower molar unknown. *M. protogonioides*, and *M. mandibularis.*

The supposed *M. baldwini*, resembles closely the species of *Hemithlæus.*

It is probable that two genera are here included under the head of *Mioclænus*. If the character is permanent, these will be distinguished as follows:

Third superior premolar with internal tubercle............... *Mioclænus.*
Third superior premolar without internal tubercle............ *Oxyclænus.*

The species of *Mioclænus* are *M. turgidus* (type); and very probably *M. opisthacus, minimus* and *M. subtrigonus*; but the diagnostic tooth has not been seen in them as yet. The species of *Oxyclænus* are: *O. cuspidatus*

and *O. corrugatus*; and very probably, *O. ferox*. The position of the *M. protogonioides*, *M. baldwini* and *M. mandibularis* is uncertain, though the last two are probably *Oxyclæni*.

The *Mioclænus cuspidatus* is distinguished among its congeners, by the transverse character of its superior molar teeth, that is, by the relatively smaller anteroposterior diameter as compared with the transverse; and by the prominence and acuteness of their principal cusps. They thus stand at the opposite extreme of the genus from the *M. turgidus*, where the teeth are characterized by the robustness and obtuseness of the cusps, although in the triangular basis of the second superior molar they agree. The external cusps are compressed cones, and in contact at the base; the intermediate tubercles are small and distinct. The internal cusp is large and prominent. The base of the fourth premolar is T-shaped, and is as long as wide. Its internal and external cusps are well developed. The cingulum of the true molars is complete all round on the last one, and on the two others except at the internal base, where it is interrupted. The second molar only displays a posterior inner tubercle of the cingulum, which is small, and does not give a truncate interior outline of the crown, characteristic of *M. opisthacus*, *M. ferox*, etc. On the ms. i and ii, the cingulum is expanded at the external angles of the crown, most so anteriorly. The anterior expansion rises in a low cusp in the P-m. iv. The enamel is smooth.

This species need only be compared with *M. opisthacus* and *M. subtrigonus*, which are of about the same size. Passing by the differences already mentioned in the table, the fourth premolar has a different form from that of the *M opisthacus*. In the latter it is narrower and more transverse, and with larger conical cusps, much as in *M. turgidus*; in the present species it has the trilobate outline seen in *M. subtrigonus*. As to the latter species, the teeth are wide, and the cusps smaller and separated at the base, and the cingulum is crenate and lobate, in a manner quite different from the smoothness and compactness of structure seen in the *M. cuspidatus*.

Measurements.		M.
Length of base of last four superior molars		.026
" " " three true molars		.019
Diameters of P-m. iv	anteroposterior	.006
	transverse	.004
Diameters of m. i.	anteroposterior	.006
	transverse	.006
Diameters of m. ii	anteroposterior	0064
	transverse	008
Diameters of m. iii	anteroposterior	.0045
	transverse	.006

D. Baldwin, discoverer.

CHRIACUS TRUNCATUS, sp. nov.

The genus *Chriacus* m. was characterized in the Proceedings of the

Academy of Philadelphia, 1883, p. 80, and two species were mentioned, *C. pelvidens* (type) and *C. angulatus*. The former of these is from the Puerco, the latter from the Wasatch formation; the former is the larger species; the latter quite small. I now add two species to the genus which are intermediate in dimensions between those already known.

I. Posterior cingulum of superior molars with large tubercle.

Large species; *C. pelvidens*; small species, *C. truncatus*.

II. Posterior cingulum with small tubercle; small species; *C. angulatus*.

III. Posterior ciugulum without tubercle; small species; *C. simplex*.

In the *C. truncatus* the posterior singular (inner) tubercle reaches the largest development, but is not present on the cingulum of the last superior molar. The anterior cingulum is weak on that tooth and on the first true molar, but on the second it is thickened into a small anterior or inner tubercle. This, with the posterior inner, gives the crown a truncate internal outline, as is also the case in the *C. pelvidens*. The intermediate tubercles are distinct, and the external cusps are separate at the base. An external cingulum. The fourth premolar has a triangular base; a single compressed external cusp, and a small acutely conical internal one. The internal tubercle is small and acute on the third premolar. The second premolar is small and probably one-rooted, and it is possible that there is no first premolar. The canine is directed vertically downwards, and the base of the crown is oval.

Besides the considerably smaller size, the posterior internal cusps are relatively larger than in *C. pelvidens*.

Measurements.		M.
Length of superior dental series including canine		.039
Length of true molar series		.014
Diameters P-m. iii	anteroposterior	.004
	transverse	.003
Diameters P-m. iv	anteroposterior	.004
	transverse	.005
Diameters M. ii	anteroposterior	.005
	transverse	.0064
Diameters m. iii	anteroposterior	.0033
	transverse	.005

Two individuals from New Mexico. D. Baldwin.

CHRIACUS SIMPLEX, sp. nov.

This species is represented by a part of the left maxillary bone, which supports the true molars except a part of the last one; and by parts of the mandible, with the first and second true molars, and perhaps one of the premolars. The true molars are about the size of those of the *C. truncatus*, but of very different detailed structure, as already pointed out. The posterior cingulum is stronger than the anterior, but does not support a trace of a cusp, and they do not unite on the inner face of the crown. External

cingulum present. External cusps rather small, separate. Intermediate cusps present; V large and distinct. Enamel smooth.

The inferior true molars support Vs; in the second the anterior is smaller and is more elevated than the posterior. The latter is continued as a raised posterior, and partly interior border of the heel, without prominent cusp. The crown has a distinct external and a very faint internal cingulum. In the supposed first true molar, the anterior V is more prolonged anteroposteriorly as in the corresponding tooth of *Mioclænus ferox*, etc., and the fourth premolar of *Phenacodus primævus*. The anterior cusp is the lowest. The heel supports three low cusps, of which the external has a crescentic section, and the posterior is the smallest.

It is probable but not certain that the fourth premolar has an internal cusp, as the tooth, presumably this one, is injured at that point, Should the internal cusp be absent, this species cannot be referred to *Chriacus*.

Measurements.		M.
Length of superior true molars		.0135
Diameters of first true molars	anteroposterior	.005
	transverse	.006
Diameters of second true molars	anteroposterior	.0053
	transverse	.007
Diameters of third true molar	anteroposterior	.0034
	transverse	.006
Diameters of first inferior true molar	anteroposterior	.005
	transverse	.0035
Diameters of second inferior true molar	anteroposterior	.0056
	transverse	.0043

D. Baldwin, discoverer.

TRICENTES CRASSICOLLIDENS, gen. et sp. nov.

Char. gen. This genus is *Chriacus* with only three premolars in the superior, and probably inferior series. The canines are well developed, and lateral in position, leaving space for small incisors, thus differing from the genera of the *Mixodectidæ*, *Mixodectes*, *Microsyops*, and *Cynodontomys*, on the one hand, and from *Necrolemur* on the other. It has, so far as known, the dental formula of several genera of typical Lemuridæ, but differs from these in the following points. The orbit is open posteriorly; the inferior molars have the anterior triangle of three cusps; and the fourth inferior premolar has an interior cusp. I have demonstrated the last mentioned characters on the type, *T. crassicollidens* only, but suspect its presence on some or all of the other species. In their details the superior true molars are like those of Mioclænus, as distinguished from those of Pelycodus.

To this genus belongs the *Mioclænus subtrigonus*, and probably, from the small size of its fourth premolar, the *M. bucculentus*. I add to these three a fourth, *T. inæquidens*, and remark that it is yet uncertain how many premolars are present in the *Chriacus simplex*. Should the latter possess three only, it will be properly referred to Tricentes.

These species differ as follows :

I. Posterior cingulum of true molars i and ii, wide, rising into a small cusp.

Length of true molars, M. .0155.......................... *crassicollidens.*

II. Posterior cingulum distinct, thickened inwards.

Length of true molars (m. ii inferential) .0175, crowns narrowed, transverse.. *bucculentus.*

Length of true molars .0170 ; crowns quadrate.............. *subtrigonus.**

Length of true molars .0135 ; crowns narrowed, transverse.............. (*Chriacus*) *simplex.*

III. Posterior cingulum weak, disappearing inwards.

Length of true molars .0105, crowns transverse except the third, which is very small.. *inæquidens.*

Char. Specif. The *Tricentes crassicollidens* is about the size of the *Chriacus truncatus* and resembles it a good deal. The latter has, however, a more transverse form of true molars, as compared with the present species, where the form is subquadrate. In the present animal the premolars are smaller, and if the third (second present) has an internal cusp, it is much more insignificant than in the *C. truncatus.* These two species and the *Mioclænus opisthacus* resemble each other in the similar size, and in the true molars having the posterior inner cusp more distinct than in other species. They differ in the dimensions of their premolars, those of the *M. opisthacus* being the largest, and those of *C. truncatus* being intermediate in size. In the *T. crassicollidens* the anterior cingulum is also distinct. The external cusps are conic, and are well separated, and the internal V is distinct. The internal cusp of the fourth premolar is small and compressed, so as to be transverse. The base of the third premolar is triangular and much longer than wide. All the superior molars, except the first premolar, are furnished with an external cingulum, which rises into a more or less distinct apex at its anterior and posterior angles. The first premolar is a simple cone. The alveolus of the canine tooth is of large size. The last true molar is not much reduced, and the first is as large as the second. This is not the case with the *T. bucculentus*, where the first is considerably smaller than the second.

Measurements.

		M.
Length of dental series to canine, exclusive		.036
" " diastema		.006
" " premolar series		.0143
" " true molar series		.0152
Diameter of P-m. iv	anteroposterior	.0042
	transverse	.0042

*There may be two species confounded under this name. A specimen figured in Vol. III of the final (4to) Report of the Hayden Survey, Plate XXIV, f, fig. 4, has four inferior premolars, all simple.

Measurements. M.

Diameter of M. i	anteroposterior	.0058
	transverse	.0050
Diameter of M. iii	anteroposterior	.0030
	transverse	.0048

A pair of mandibular rami, found on the same day, and at or near the same place, probably belong to the same species, if not to the same animal, they support all the teeth, but only the P-m iv and the M. i and ii have yet been disengaged from the matrix. The P-m. iv is rather large and robust, and has a short wide heel, and an anterior cusp which leaves the main cusps half way to the apex, or at the same elevation as the internal cusp. The anterior three cusps of the true molars are elevated above the heel, and the anterior is nearly median, forms no blade with external anterior, and is smaller than the anterior internal cusp. The heel is well developed, and its borders rise in two obtuse open Vs, whose apices look away from each other. The internal supports two cusps, the external, but one. No cingula; enamel smooth.

Measurements of inferior teeth. M.

Diameters of P-m. iv	anteroposterior	.0060
	transverse	.0035
Diameters of m. ii	anteroposterior	.0050
	transverse	.0039
Length of bases of m. i and m. ii		.0110

From Upper Puerco; D. Baldwin.

TRICENTES INÆQUIDENS, sp. nov.

This species is represented by two mutilated crania, obtained on the same day and near the same locality as the preceding species. One of these, which I select as type, embraces the muzzle and palate anterior to the posterior border of the maxillary bone.

Besides its inferior size, other characters distinguish this species. The simplicity of the superior molars is seen in no other, and the very reduced size of the third superior molar is not found in any of its allies. This is correlated with an oblique reduction of the maxillary bone behind, which gives the second true molar an oblique external border instead of the longitudinal one seen in the other species. The external cusps of the molars are conic, and are not in contact at the base. The internal cusp is also conic, and is larger than the external. The internal cusp of the fourth premolar is large. It is probable that the third premolar supports an internal cusp, as the crown base is as wide as long. The premolars are spaced in this species, as in the last, but the diastema is shorter than in the *T. crassicollidens*, not exceeding the premolar interspaces. The external cingulum is quite weak. The canine alveolus is large. The incisors are wanting, but the premaxillary region is wide. The inferior dentition is unknown.

Measurements of superior teeth.		M.
Length of dental series, including canine		.0272
" from canine to m. i, exclusive		.0130
Length of true molar series		.0100
Diameter of P-m. iii	anteroposterior	.0028
	transverse	.0025
Diameters of P-m. iv	anteroposterior	.0030
	transverse	.0042
Diameters M. i	anteroposterior	.0038
	transverse	.0048
Diameters M. ii	anteroposterior	.0039
	transverse	.0059
Diameters M. iii	anteroposterior	.0015
	transverse	.0024

Upper Puerco; D. Baldwin.

INDRODON MALARIS, gen. et sp. nov.

Char. gen. Family Anaptomorphidæ, suborder perhaps Lemuroidea, as indicated by the dentition only. It differs from *Anaptomorphus* in three points. First, there are three superior incisors; second, the first (third) premolar has no internal lobe; and third, there is a distinct posterior internal tubercle on the first and second superior molars.

The animals of the Eocene period of the family of the *Adapidæ*, may belong to the *Lemuroidea*, but the evidence which I have derived from the feet of *Pelycodus** has led me to refer them† to the Insectivorous division of the Bunotheria, to the neighborhood of the Tupæidæ and Erinaceidæ. At the same time I retained provisionally the genera with three and two superior premolars in the suborder Lemuroidea, although the foot structure of these extinct genera is yet unknown. I also indadvertently defined the Lemuroidea as having quadritubercu1ate superior molars, a character which I well knew to be wanting in various extinct and recent genera where they are tritubercular. Two families were proposed† for the Eocene lemuroids, which are defined as follows:

Superior premolars three .... *Mixodectidæ.*
" " two .... *Anaptomorphidæ.*

The genera of the first named family are defined as follows:

I. Canine teeth large and lateral, well separated.
First superior premolar without internal lobe; superior true molars tritubercular with cingula .... *Tricentes.*

II. Canine teeth median in position or much reduced in size.
a. Last inferior premolar without internal tubercle.
Inferior premolars all one-rooted; canine and incisor small. .*Necrolemur.*‡

* Report of U. S. G. G. Survey W. of 100th Mer., G. M. Wheeler, iv, p. 140.
† Proceedings Academy Natural Sciences of Philadelphia, 1883, p. 78–80.
‡ Filhol Rech. Phosph. Quercy.

First premolars only one-rooted ; canine small ; incisor very large...*Mixodectes.**

aa. Last inferior premolar with internal tubercle.

A very large ? canine ; first premolar only, one-rooted.......*Microsyops.*†

A very large ? canine ; first and second premolars both one-rooted...*Cynodontomys.*‡

The genera of Anaptomorphidæ, which on dental characters includes *Indrodon*, differ as follows :

a. Incisors three.

First superior incisor without inner lobe ; posterior inner tubercle present on first and second tubercle.................*Indrodon.*

aa. Incisors two.

First superior incisor with inner lobe ; no posterior inner tubercle on superior molars ....*Anaptomorphus.*

The superior dental formula of *Indrodon* is I. ^{3} ; C. ^{1} ; P-m. ^{2} ; M. ^{3}. The canine is compressed and acute ; the third premolar is compressed conic, and has two roots. The fourth premolar has but one external cusp. The external cusps of the true molars are conic and acute, and are connected with the internal cusp by ridges which form a V. Posterior inner cusp distinct on ms. i and ii, a part of the posterior cingulum. Intermediate tubercles present, small. The superior incisors are well developed, and display no tendency towards the rodent type. A portion of lower jaw adheres to the skull, and may belong to the same animal. It supports the last two molars. These have two anterior, opposite, approximated cusps. The heel of the penultimate molar is rather large, and has a raised edge, which develops low tubercles at the angles.

Char. Specif. The first and third superior incisors are a little larger than the second. Canine preceded and followed by diastemata, each of which is 1.5 times as long as the long diameter of the base of the crown. Premolars separated from each other and from the first true molar by interspaces half as long as the diastema. Neither tooth has any basal tubercles, but the posterior has a weak external cingulum, which is stronger posteriorly. The internal cusp of the same tooth is anterior, is acute and elevated. The superior true molars have a strong external cingulum, which rises into a small tubercle opposite the space between the external principal cusps. Of the latter, the anterior is a little more conic than the posterior, and both are well within the external border. On the last molar, the posterior external cusp is continuous with the external intermediate tubercle, and forms a cutting edge within the posterior margin of the crown. The posterior inner tubercle is rather large, and projects further inwards than the apex of tne anterior V on the second true molar, but not so far as in the species of *Anisonchus* and *Haploconus.*

* Proceedings American Philosophical Society, 1883, p. 559.

† Leidy Report U. S. Geol. Survey, Terrs. I.

‡ Cope, Pal. Bull. No. 34.

The surface of the cranium is too much obscured by cracks and films of matrix to permit a view of the sutures and foramina. The face is wide, as the posterior part of the maxillary and the malar bone are expanded outwards. I have not yet been able to ascertain the condition of the orbit posteriorly. The mandibular ramus is rather slender.

Measurements.			M.
Length of dental series from posterior base of i iii			.0248
"	" bases of superior incisors		.0060
"	from i iii to P-m. iii, exclusive		.0074
"	of premolars on maxillary bone		.0060
"	" base of P-m. iii		.0030
"	" P-m. iv		.0028
Width	" "		.0038
Diameters m. i	anteroposterior		.0030
	transverse		.0032
Diameters m. ii	anteroposterior		.0033
	transverse		.0040
Diameters m. iii	anteroposterior		.0030
	transverse		.0040
Diameters inferior m. ii	anteroposterior		.0032
	transverse		.0030
Depth of ramus mandibuli at m. ii			.0070

The skull is about the size of that of the *Bassaris astuta*. D. Baldwin, discoverer.

The discovery of this type in the Puerco formation is a fact of interest. In the shortening of its dental series it is the most specialized genus of the epoch, while the forms of its true molars are like those of the simpler Creodonta, and more specialized than those of *Anaptomorphus*, and the lemurs generally. In the simplicity of its premolars, however, it maintains the general character of the Puerco fauna, and is more primitive than the forms just named. Its nearest ally of the Puerco yet known is *Chriacus*.

ANISONCHUS AGAPETILLUS, sp. nov.

This species is founded on parts of six mandibular rami, none of which has more than four continuous molars in position, including the last. It is not entirely certain that these belong to a species of *Anisonchus*, because the superior molar teeth by which that genus is distinguished from *Haploconus* and *Hemithlaeus*, are wanting. The inferior molars have the anterior inner cusp moderately well developed, as in *Anisonchus gillianus*.

The crowns of the true molars consist of two Vs; of which the posterior base of the posterior one, is rendered irregular by the presence of a small posterior median tubercle. Of the anterior pair of cusps, the external is little the more elevated, and the internal is more elevated than any of the posterior ones. The internal posterior as well as the external posterior

cusp has a V-shaped section, because its anterior border is continued as an oblique ridge to the base of the anterior internal cusp. Internal cingular none ; a slight one on the external base of the large anterior external cusp. The heel of the third true molar is well developed, and rises into an acute cusp. That of the fourth premolar is short and flat. The anterior cusp of the same is basal and rudimental. This tooth is not enlarged as is usually the case in the *Periptychidæ*, and it first here differs from these animals, and agrees with the unguiculate types in that its lateral faces are unequally convex.

Measurements.	M.
Length of last four molars on base	.014
" " fourth premolar	.0035
Elevation of " "	.0038
Length of second true molar	.0031
Width " " " (greatest)	.003
Length of third " " "	.004
Width " " " "	.0028
Depth of ramus at second true molar	.007

ANISONCHUS COPHATER, sp. nov.

A mandibular ramus supporting three molars, two of them true, is all that I have seen of this species. Its proportions are the same as those of the *A. agapetillus*, that is, much smaller than the *A. gillianus*, and the single premolar is much more like that of other species of the genus. The true molars differ from those of the *A. agapetillus* in two strong characters. First, the internal posterior cusp is inside the rim of the heel of the crown, that is, outside the bordering edge, and is therefore very distinct from the posterior median cusp. It is a sharp cone ; secondly, there is a cingulum extending from this cusp round the internal base of the internal anterior cusp. There is also one at the base of the external anterior cusp, which continues to the heel only on the last inferior molar. The posterior heel is relatively wider, and the anterior V relatively more contracted, than in the *A. agapetillus*. The anterior tubercle is moderately developed at the anterior base of the anterior V. The third or fourth premolar is equilateral, and larger than the true molars. It has a short apiculate heel, and a rudimental anterior basal tubercle.

Measurements.			M.
Diameters of m. ii	horizontal	anteroposterior	.0032
		transverse	.0030
	vertical	anterior	.0025
		posterior	.0013
Diameters of P-m. iii or iv		anteroposterior	.0043
		vertical (restored apex)	.0040
		transverse	.0023

D. Baldwin, discoverer.

CHIROX PLICATUS, gen. et sp. nov.

Char. gen. These are known from three superior molars ; viz : the last

premolar, and the second and third true molars. The fourth premolar has two external, and one internal cusps, and the true molars have four cusps each. The cusps are of peculiar form. The second true molar resembles a convex body which has been divided by two cuts at right angles to each other, from which the quarters thus produced have spread away from each other subequally. The external faces of the cusps are convex. The apices are acute. The last superior molar is larger anteroposteriorly than transversely. The fourth premolar (supposed) is two-rooted.

These molar teeth remind one of the inferior molars of *Ptilodus*, through they differ much from them. The genus is probably nearer to *Catopsalis*, and belongs to the Marsupial order. The presence of only two series of cusps in the superior molars, distinguishes it from these genera, which have presumably three series of such cusps. Lemoine has shown this to be the case in *Neoplagiaulax*.

Char. specif. The external cusps of the fourth premolar are flattened on the external side, and lean a little inwards. The internal cusp (probably homologically the anterior) is opposite the anterior external, and has a convex internal face. Its apex is acute and compressed; the apices of the external cusps are trihedral and acute.

The cusps of the second true molars are more widely separated transversely than anteroposteriorly; that is, the longitudinal fissure is wider than the transverse. The apices are all acute, the internal trihedral, the external more compressed.

The transverse diameter of the last true molar is smaller than that of the second true molar, while the longitudinal is nearly the same. The crown projects convexly posterior to the posterior pair, and there is a small tubercle at the anterior base of the external anterior cusp.

None of the teeth preserved display cingula. The bases of the crown are smooth, but the cusps are sharply and finely parallel-grooved on their external faces.

Measurements.		M.
Diameters of P-m. iv	anteroposterior	.0030
	transverse	.0038
Diameters of m. ii	anteroposterior	.0033
	transverse	.0035
Diameters of m. iii	anteroposterior	.0035
	transverse	.0030

D. Baldwin, discoverer.

CATOPSALIS FISSIDENS, sp. nov.

This Marsupial is represented by a portion of the lower jaw which supports the molar teeth. The first, which is probably the fourth premolar, is represented only by its single root, which fills a round alveolus near the anterior base of the first true molar.

In size this species is intermediate between the small *C. foliatus* and the large *C. pollux*. The first molar is the longer and narrower, and the

second the shorter and wider, as in the known species. The first molar differs from that of both the latter, in having the tubercles of one side separated nearly to the base. These tubercles are conic, and not flattened as in *C. foliatus* and *C. pollux*, and the two rows are separated by a distinct valley, as in the first named. There are five tubercles on one side, and four on the other side of the crown, and in addition, two small cusps at the anterior extremity of each row, and another at the posterior extremity of one of the rows. These additional cusplets are not present in the other species.

The last molar is relatively wider than in the other species. Its crown is a good deal worn, but there are probably more than two rows of tubercles, as there are some appendicular rows on one side of the crown at least.

Measurements.		M.
Diameters M. i	anteroposterior	.0135
	transverse	.0050
Diameters M. ii	anteroposterior	.0090
	transverse	.0075

The Upper Puerco ; D. Baldwin.

General remarks on the characters of the Mammalia of the Puerco Epoch.

I have already called attention to the fact that the Mammalia of the Puerco epoch possess, with but few exceptions, superior molar teeth whose crowns include only three of the component tubercles of the normal mammalian molar, in a condition of full development.* In the number of species of supposed placentals now known, sixty seven, the proportion of species (1), with quadritubercnlate superior molars is even smaller, being only four to sixty three. The premolars display equally primitive characters, and to these I wish now to draw attention.

2. The presence of two internal tubercles of the fourth superior premolar is unknown as yet in the fauna.

3. The presence of two external cusps of the same tooth is known or inferred in only five species in the sixty seven, and in two of the five it is of reduced size.

4. The presence of one internal cusp of the fourth superior premolar is demonstrated or inferred in all of the placental species.

5. The presence of the internal cusp of the third superior premolar is, on the other hand, only demonstrated in twenty-two species. In seventeen it is wanting.

Referring to the inferior premolars :

6. No species presents an internal cusp of the third premolar.

7. An internal cusp of the fourth premolar is present in only fourteen species. In twenty nine species it is certainly wanting.

* Proceedings of the American Philosophical Society, 1883, 562. American Naturalist, 1883, 407.

8. In no species of this formation is the fourth inferior premolar like a molar tooth.

It is thus evident that the dentition of the mammalia of the Puerco fauna presents a much greater degree of simplicity than does that of the species of any of the later Eocene or other age. This result coincides with the results I have already obtained from a study of the structure of the feet, etc.* These may be summarized again as follows:

1. The species in which the number of toes is known, have them 5-5.
2. Those in which the feet are known are plantigrade.
3. No species is known to have interlocking carpal and tarsal bones, excepting the two species of *Pantolambda* (carpus unknown).
4. No species is known to have well grooved astragalus (its presence is inferred in two species of *Dissacus*).
5. No species is known to have a faceted radius or ulno-radius, adapted to the separate carpal bones of the proximal row.
6. In no species is the tongue in the metapodio-phalangeal joints developed on the front of the metapodial bones.
7. The zygapophyses where known are all flat, except in some species (probably all) of *Oxyclænus*, where they are simply convex-concave, and not doubly so.

On the Trituberculate Type of Molar Tooth in the Mammalia. By E. D. Cope.

(Read before the American Philosophical Society, December 7, 1883.)

It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular or tritubercular; that is, with two external and one internal tubercles.† Thus, of sixty-seven species of placental mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of the remaining sixty-five, all are triangular, excepting those of three species of Periptychus, and three of Conoryctes, which have a small supplementary lobe on each side of the median principal inner tubercle.

This fact is important as indicating the mode of development of the various types of superior molar teeth, on which we have not heretofore had clear light. In the first place, this type of molar exists to-day only in the insectivorous and carnivorous Marsupialia; in the Creodonta, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades). In the Ungulates its persistence is to be found in the molars of the Coryphodontidæ of the Wasatch, and Dinocerata of the Bridger Eocene. In later epochs it is occasionally seen only in the last superior molar.

It is also evident that the quadritubercular molar is derived from the tritubercular by the addition of a lobe of the inner part of a cingulum of the

* American Naturalist, 1883, p. 1036; Science, 1883, p. 275.

† See American Naturalist, April, 1883, p. 407.

posterior base of the crown. Transitional states are seen in some of the Periptychidæ (*Anisonchus*), and in the sectorials of the Procyonidæ.

The trituberculur or triangular superior molar is associated with a corresponding form of the anterior part of the inferior molar. This kind of inferior molar* I have called the tubercular sectorial, and is very variable as to the degree of development of the sectorial cutting edge. The anterior triangle is formed by the connection by angle or crest, of the median and anterior internal crests with the anterior external. Its primitive form is seen in Didelphys, Pelycodus Pantolambda and the Amblypoda generally; in Centetes and Talpa, and in its sectorial form, in Stypolophus and Oxyæna, etc.

The mechanical action of such teeth is as follows: Of course, it results from the form of the superior molars that the spaces between them are wedge shaped, the apex external, the base opening to the palate. The base of the triangular section of the anterior part of the inferior molar is interior and the apex exterior, and when the jaws are closed, this triangular prism exactly fits the space between the superior molars. The lower heel of the inferior molar receives the impact of the crown of the superior molar. Thus the oblique edges of the inferior triangle shear on the edges of two adjacent superior molars. The anterior parts of the inferior molars, and the superior molars, form an alternate dental series as distinguished from the prevalent opposed dentition of most mammalia. In so far it resembles the reptilian dentition.

This primitive dentition has been modified in two directions; viz., to form the grinding and the sectorial dentitions. As already remarked, the superior molars gradually acquire a posterior internal lobe, which produces the quadrituberculate type. This lobe, by opposing the anterior internal lobe of the next posterior inferior molar, precludes the entrance of the anterior triangle of the latter between the two superior molars. Hence we find in the types which possess quadritubercular superior molars, that the anterior triangle of the inferior molar is not elevated, if present, as for instance in Rhinoceros. It is, however, more frequently atrophied, and disappears forming the inferior quadritubercular molar so well known.

On the other hand, as I have pointed out,† the anterior internal cusp of the triangle of the inferior molar may be more developed antero-posteriorly, giving the antero-internal edge of the triangle much greater obliquity than the postero internal. In correspondence with this modification, the superior triangular molar loses its equilateral character by the more anterior position of its internal angle, thus elongating the posterior internal side of the crown. The latter thus fits the corresponding form of the triangle of the inferior molar, forming with it the shear of the sectorial tooth.

* See Report G. M. Wheeler, D. Chief of Engineers on Explor. Surv. W. 100th Mer. Vol. IV, pt. II, on the Creodonts.

† On the origin of the sectorial tooth of the Carnivora, American Naturalist, 1879.

In a former article, "On the Homologies of the Molar Teeth," etc., I traced the modifications of the superior and many of the inferior molars of the ungulate mammals to a parent quadrituberculate type. In a subsequent essay* I traced the origin of the inferior sectorial to a primitive five-tubercled, or "tubercular sectorial" type. Farther than this I did not go, and made no attempt to derive the few cases of triangular superior molars then known, nor the type of the superior sectorial. The revelations of the Puerco fauna show, that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a "tubercular sectorial" type. Shall we look for the origin of the latter in a tritubercular tooth also, *i.e.*, tubercular sectorial without heel; and will the crowns of the true molars of the primitive mammals alternate with, instead of oppose each other? This is a probable result of future discovery.

On the Synchronous-Multiplex Telegraph. By Prof. Houston.

(Read before the American Philosophical Society, December 7, 1883.)

Prof. Houston said: "It is with considerable pleasure, Mr. President and gentlemen, that I am here this evening to call your attention to a discovery in electricity that appears to me to be of very great practical value to the world. The present decade has witnessed such marvelous progress in electrical inventions that many of us have perhaps been disposed to believe that but little new could reasonably be expected, but, unless I am greatly mistaken, the invention which I am about to describe to you, is greater even than that of the telephone.

"Before proceeding to the details of the invention of the synchronous-multiplex telegraph system of Mr. Patrick B. Delany, it will, perhaps, be best that your attention should first be called to some of the practical purposes for which it is applicable. Briefly stated, the value of this invention is to be found in the fact, that by its use the simultaneous transmission of numerous telegraphic dispatches over one and the same wire is readily accomplished. Hitherto, the only system that accomplished this, to any considerable extent, in actual practice, was the quadruplex system, and this, as you well know, is not only limited to the simultaneous transmission of four dispatches, but these are necessarily sent, two each, in opposite directions. You will, therefore, readily understand the great value of Mr. Delany's wonderful invention, when I inform you that not only can the number of simultaneously transmitted dispatches be very greatly increased, even indeed as far as seventy-two, but that all of them can be sent in t-

*Journal Academy Natural Sciences, Philadelphia, March, 1875.

same direction, or any part in one direction and the remainder in the opposite direction.

"It would be difficult, on the eve of an important discovery like that we are discussing, to predict the extent and nature of the effect its practical introduction will have on the world at large; but this I think will appear evident, that the synchronous-multiplex telegraphic system will do for the most distant cities of our country, what the telephone has done for the inhabitants in the same city, or for those of neighboring cities, with, however this difference, that in the case of the synchronous system, a permanent record is obtained of all dispatches sent or received, while in the telephone system of transmission there is none.

Without, however seeking to look further into the future, let us pass to the descriptions of the details of this remarkable invention.

"The multiplex system differs radically from the quadruplex, which, as you are probably aware, is based on the balancing of resistances, or the differential method. The multiplex system, on the contrary, is based on the synchronous rotation of two trailing contact arms which are connected to the ends of the line, one at each end of the main line. Series of contacts, on the face of discs, swept by the trailing arms, are in electrical connection with the various operators that desire to use the line. By the rotation of the arms, the main line is brought successively into electrical contact with each of the operators, and carried from one to another, and again given back to each successively, so rapidly, that before any of them can realize that he has been disconnected from the line, it is again given to him, so that the line is at his disposal to the same extent as if he alone was using it.

The appliances whereby Mr. Delany maintains practically absolute synchronism in the revolving arms at each end of the line are of remarkable simplicity. A few of the contacts before referred to, as being placed on the face of the discs, are reserved for the maintenance of synchronism. Some of these contacts are connected to a battery and others to correcting devices at each end of the line, while others are left open or unconnected with anything. If the synchronous rotation of the two arms is maintained, no correcting impulses pass over the line, since, although one end thereof is in electrical connection with one of the batteries, the other end is on an unconnected segment, and the battery circuit being open, no current flows; should, however, the line at one end be brought in contact with a part of the disc, very slightly in advance of its position on the disc at the other end, then the battery is connected, and an electrical impulse flows over the line, and slows the rotation of the arm.

The manner in which this correcting impulse is made a retarding one is as follows: the rotation of the trailing arm at each end of the line is maintained by an electric magnetic device, invented by LaCour, of Copenhagen, and termed by him a phonic-wheel. The rapidity of rotation of this wheel is dependent on the rapidity with which an electrical current traversing the coils of its electro magnet, is made and broken.

"The makes and breaks in the circuit of the motor-magnet of the phonic-

wheel, are governed by the vibration of a tuning-fork, maintained in its vibration by the action of a voltaic battery. Since the rate of vibration of the fork governs the rate of rotation of the arm, it is only necessary to maintain the synchronous vibration of two forks, placed at each end of the line.

"Although the duration of vibration of a fork, like the oscillation of a pendulum, is sensibly the same for all amplitudes, provided the amplitude is very small, yet, as you are aware, the duration becomes longer, or the vibration slower, if the amplitude of the oscillation be very sensibly increased. Now the inventor obtains the requisite slowing of that fork's vibration, that is connected with the phonic-wheel that has gained on the other, by causing the electrical impulse that flows over the line to increase the strength of the electrical current that is traversing the battery circuit that is keeping it in vibration. This he accomplishes by cutting a resistance out of this circuit, and thus allowing more current to pass.

"In order to avoid the disturbance produced by the static charge, that is generally found in long lines, the inventor has provided a series of extra contacts, placed between each of the separate contacts that, at each end of the line, are connected to the transmitting or receiving instruments. These extra contacts are connected together and to the earth, so that when the line is disconnected from one instrument, it is put to the earth before it is given to the next instrument, and is thus completely freed from its static charge. These discharge contacts are absolutely necessary to the successful operation of the synchronous system, where the length of line employed is extended.

"Since the circuit of any operator is constantly made and broken, as often as the line is taken and again returned to him, the use of an ordinary Morse relay would be inapplicable in the practice of this system, since all the impulses (a number of which make up a single character, as well as the characters sent into the line from the transmitting key of the operator connected) would be recorded. In order to avoid this confusion the transmission battery is split and grounded in the middle, and polarized relays substituted for the ordinary instruments. Since these relays respond, not to makes and breaks in the circuit, but to changes of polarity only, the receiving instruments are influenced only by the characters sent by the operators, and not by the successive makes and breaks.

"The successful solution of the problem of maintaining synchronism by the methods I have explained, render many things possible that without it would have been impossible. Among these I may mention the various applications of fac-similies, and autographic telegraphs. Without attempting to go into the details of their application, it will suffice to say that the probable applications of Mr. Delany's system are so numerous and important as to entitle him to a very high rank among the world's inventors."

Stated Meeting, December 21, 1883.

Present, 8 members.

President, Mr. FRALEY, in the Chair.

A letter from Bishop de Schweinitz, dated Bethlehem, Dec. 12th, enclosing a certified extract from the minutes of the "Board of Directors of the *Society of the United Brethren for Propagating the Gospel among the Heathen*," was read, and, on motion, it was

Resolved, That the Curators be authorized and requested to return the Zeisberger and Perlæus documents to their proper owners, and take a receipt for the same.

Donations for the Library were received from the Society at Riga, the Royal Society of Victoria, Royal Academy and Prof. Paul Albrecht of Brussels; Geographical Society of Paris and Bordeaux; the Institute of France; Royal Academy at Madrid; Meteorological, Zoölogical, and Royal Asiatic Societies at London; Cambridge Museum of Comparative Zoölogy; American Oriental Society; Prof. Oswald Seidensticker, Prof. Edwin J. Houston, and Mr. Henry Phillips, Jr.; Mr. Wm. Hand Browne of Baltimore, American Journal of Mathematics; United States National Museum; J. L. Smithmeyer; Ohio Mechanics' Institute of Cincinnati; and the American Antiquarian and Oriental Journal.

Also framed phototypes of the Smithsonian Institution Building, and of Henry W. Longfellow, presented by Mr. F. Gutekunst of Philadelphia.

The death of Dr. Thomas S. Kirkbride, Superintendent of the Pennsylvania Hospital for the Insane, in West Philadelphia, on the 17th of December, aged 74, was announced by the President, who was requested to appoint a member of the Society to prepare an obituary notice of the deceased.

A communication for the Magellanic Premium was received through the President from "Time is Money," consisting of a description and model of "A Universal Time-piece." Referred to the Board of Officers and Council.

Prof. Rothrock read a paper entitled: "The microscopic examination of timber with regard to its strength: a contribution from the Eli K. Price Botanical Laboratory of the University of Pennsylvania, by Frank M. Day." Remarks were made on the interesting subject of the paper by Dr. Brinton, Mr. Ingham and Mr. Price, and the Treasurer was authorized to pay for necessary illustrations. (See page 333.)

Mr. Phillips communicated "A note respecting the correct name of the last letter of the English Alphabet?"

Mr. Lesley exhibited a small copper-plate map of Pennsylvania which he had colored geologically according to the system of Major J. W. Powell, Director of the United States Geological Survey, as a contribution to a general map of the United States now in preparation at Washington for illustrating the coloration adopted by Major Powell, and intended for presentation at the Congress of Geologists to meet at Berlin in 1884.

Dr. Allen read a paper "On a case of human congenital malformation," and exhibited two photographic views of the subject.

The reading of pending nominations was postponed.

Mr. Phillips reported that the Curators were consulting with Mr. Rothermel respecting the oil paintings of the Society.

The Report of the Finance Committee was received.

The annual appropriations for 1884 recommended therein were passed.

And the meeting was adjourned.

A Note respecting the Correct Name of the Last Letter of the English Alphabet. By Henry Phillips, Jr.

(Read before the American Philosophical Society, December 21, 1883.)

A dislike of what seemed to be a growing evil, one which had greatly increased within the past twenty years, the misnomer of the last letter of the English alphabet, by which it was called *zee* instead of *zed*, led me to investigate so far as the material was accessible to me into the origin of this usage, and into the authorities by which it was countenanced. I have

accordingly consulted various English Dictionaries, of which I subjoin a list, from the year 1656 to the present time, with the following results, viz.:

1. That the name *zee* for *zed* (or *izzard*,* as the letter was formerly termed), seems to have made its appearance in the first edition of Webster's Dictionary of the English Language, published in 1828. But in the editions of that work, published respectively in 1860, 1864 and 1869, and possibly earlier, *zed* is given as the *English* name of this letter, while *zee* is the American. It is noteworthy that Webster seems to have no authority for his change of nomenclature, nor can I find in his published writings any reason therefor, unless it be perhaps that some petty local peculiarity in the small country towns of New England led him to believe that no other pronunciation could be a correct one. In a Dictionary of the English Language, "by an American Gentleman," published in Burlington, New Jersey, in 1813, the name is given as *zed*.

As conclusive of former usage, the passage in *Lear*, Act II, Scene 2, may be quoted:

"Oh thou Zed! thou unnecessary letter."

I have not been able to find in Ben. Johnson's English Grammar any usage bearing on this point.

2. The analogy with the similar letter *z* of the German alphabet, of which the name is *tsett*, certainly deserves respect.

Freeman, in his impressions of the United States (p. 84), writes: "I think I see another instance of the schoolmaster in the name which in some parts of America is given to the last letter of the alphabet. This in New England is always *zee*; in the South, it is *zed*, while Pennsylvania seems to halt between the two opinions. Now *Zed* is a very strange name. * * * Does it come from the old form *izzard* * * which I was delighted to find remembered in America. * * * But *zee* is clearly a schoolmaster's desire to get rid of the strange sounding *zed*, and to make *z* follow the analogy of (some) other letters. But this analogy is wrong; *z* ought not to follow the analogy of *b*, *d*, *t*, but *l*, *m*, *n*, *r*, and above all of its brother *s*, so that if we are not to have *zed*, the name should clearly be *ez*."

But there seems no necessity or reason why any change whatever should take place in this respect.

3. From the forty-seven dictionaries which I have consulted I obtain the following result:

Name of the letter given as *zed*	24
" given as *zee* (none earlier than 1828, and all American)	3
" of letter not given at all	20
	47

* Nares' Orthoepy, I, 188, London, 1792, speaks of the letter as *izzard*; than which, however, he considers that the name *zad* would be "more elegant and proper."

LIST OF DICTIONARIES CONSULTED.

1656.	T. B.,	London,	not given.
1678.	Phillips, World of Words,	"	not given.
1691.	Sewell, Dutch and English,		not given.
1720.	Phillips,		not given.
1736.	Bailey,	London,	not given.
1748.	Junius,	Oxford,	not given.
1755.	Johnson,	London,	zed.
1757.	Serenius, English and Swedish,	Nykoping,	zed.
1771.	Skinner,	London,	not given.
1775.	Ash,	"	not given.
1780.	Sheridan,	"	not given.
1782.	Cox,	"	zed.
1783.	Kendrick,	"	not given.
1783.	Barclay,	"	not given.
1784.	Nare's Orthoepy,	"	zed.
1785.	Johnson,	Dublin,	not given.
1789.	Sheridan,	Philadelphia,	not given.
1795.	Ash,	London,	zed.
1797.	Walker,	"	zed.
1804.	Jones,	"	zed.
1805.	Perry,	"	not given.
1806.	Johnson,	"	zed.
1813.	Barclay,	Bungay,	not given.
1813.	"An American Gentleman,"	Burlington, N. J.,	zed.
1818.	Johnson,	Philadelphia,	zed.
1819.	Johnson.	"	zed.
1824.	Walker's Rhyming Dictionary,	London,	zed.
1828.	Webster, first edition.		zee.
1835.	Booth,	London.	not given.
1835.	French, German and English,	Leipzig,	zed.
1841.	Fleming and Tibbin, French and English,		zed.
1845.	Knowles,	London.	not given.
1846.	Bolles, Phonographic Pronouncing,	New London,	zee.
1851.	Richardson.	Philadelphia,	not given,
1853.	Todd, Johnson and Walker,	"	zed.
1853.	Millhouse, Italian and English,	Milan,	zed.
1856.	Ogilvie's Imperial,	London,	zed.
1857.	Nare's Glossary,	"	zed.
1860.	Worcester,	England, zed; in the U. S. zee.	
1860.	Johnson,	London (Bohn),	zed.
1862.	Reiff, Russian, French, German and English,		zed.
1863.	Wilson, French and English,	"	zed.
1864.	Webster,	Springfield,	zed (also izzard).
1866.	Grieb, German and English,	Philadelphia,	zed.
1869.	Webster.	Springfield,	zed.
1880.	Webster.	"	not given.
1882.	Skeat,	Oxford,	not given.

This brief note is simply intended as a suggestion to call the matter to the attention of those better qualified to consider it than myself.

NOTE.—Since the foregoing went to press I have found in reading Taylor's History of the Alphabet (London, 1883), the following matter bearing upon this subject, and confirmatory of my views:

"The name *zed* is a survival of the early *tsadde*. (Vol. II, p. 137). * * *

Z was the last introduced of the letters of the Roman alphabet. * * * It crept into English during the fifteenth century from the French, and in use is now pretty nearly restricted to foreign loan-words * * * *çedilla* means *little zed: zediglia* is the diminutive for *zeticula.*" p. 138.

The Microscopic Examination of Timber with regard to its Strength. A Contribution from the Eli K. Price Botanical Laboratory of the University of Pennsylvania. By Frank M. Day.

(*Read before the American Philosophical Society, December 21, 1883.*)

The valuable paper of Dr. J. T. Rothrock upon "Some Microscopic Distinctions between Good and Bad Timber of the Same Species," recently read before the American Philosophical Society, has opened a broad field for original investigation. The question there suggested as to the possibility of approximately determining the strength of timber by microscopic examination (involving as it does the question of the "differences in the strength of wood due to the molecular differences in the structure of the fibre") is one that can be answered only after the most extended and carefully conducted investigation.

As long as we confine ourselves to the examination of various specimens of the same species the task of distinguishing the good pieces from the bad, and of roughly predicting the relative strains which they will resist, is comparatively easy.*

Plate I showing transverse sections of two pieces of Rock Elm (*Ulmus racemosa* Thomas), furnishes illustrations of the general differences between good and bad wood of the same species. The upper figure is a section of the wood used by a well-known firm in their highest grade of hubs; the lower is a section of wood which they declare to be practically worthless. It is evident from a glance at these drawings that the good differs from the bad, in 1st, The much smaller area occupied by ducts; 2d, The smaller bore and consequently thicker walls of the woody fibres; 3d, The more compact arrangement of the woody fibres, giving them a polygonal rather than a circular outline; 4th, The much greater annual growth. These are the elements which it is but reasonable to suppose would give strength to the wood. They are further those which are found to do so in the great majority of cases.

The strength of the cellulose of which the wood is composed, is, in various species and under various conditions, by no means the same. For example, Buttonwood (*Platanus occidentalus* L.) rapidly loses the greater part of its strength, by a natural process which the woodsmen call "doating," the only indication of which is a bleaching of the tissues. Hence any statements as to the strength of timber, made from an examination of the structure alone are open to question.

* This it will be urged can be done by the practical eye without the aid of the microscope, but it must be remembered that the entire investigation of the subject is, at its present stage, of theoretical rather than practical interest.

We are, however, able to leave this uncertain element out of consideration when we turn our attention to the following experiments upon the transverse strength of the coniferous woods, the results of which point to an almost identical value for the strength element of the cellulose in the several pieces tested. Each piece was exactly one and a half inches square by two feet nine inches long, and rested upon rounded edges at a distance of two feet six inches apart. The pressure was gradually applied at a point half way between the supports, and the deflection was taken at each hundred pounds.

Plate II shows, side by side, transverse sections of three pieces thus tested. The detail of the experiments are exhibited in the following table:

Letter of Experiment.	NAME OF WOOD.	Specific Gravity.	Greatest Strain	Effect of Greatest Strain.	Deflection with Greatest Strain	Deflection with 700 lbs	Length of Woody Fibre	Average Annual Growth.
			Lbs.		In	In	In.	In.
H	Yellow Pine (*Pinus* sp?)	.817	2000	Broke.	.84	.20	165	125
L	White Pine (*Pinus Strobus* L.)........	.415	1490	Broke.	1 21	.43	.169	083
E	Hemlock *Abies Canadensis* Michx	.422	1000	Broke.	.98	.36	176	071

These results, taken in connection with an examination of the sections, indicate a great probability that in the coniferous woods the strength depends chiefly upon the ratio of the number of thickened autumn-fibres to the total number of fibres formed during the year, becoming greater the greater the number of thickened fibres. Thus it is seen that in *H*, by far the strongest of the three pieces tested, the thick-walled fibres occupy almost half the year's growth, while in *E* they form a mere strip at the end of the growth. In connection with this statement it may be well to remark that the absolute breadth of the annual growth in the coniferous woods does not seem to be as important an element in the problem of strength as in the so called "hard woods" (*Angiosperms*). The reason of this is the absence of the ducts which in the "hard woods" are formed, as a rule, in the early part of the annual growth. After this the solid wood is formed. Hence, the value in them, other things being equal, of a large annual growth.

The ease with which the results of the tests upon the coniferous woods are explained gives place to the greatest difficulty in the case of the hard woods. Important factors in this case, and ones which we have not been called upon to consider in the coniferous woods, are, 1st, the weakness due to a greater or less abundance of ducts, and second, the strength added by more or less highly developed medullary rays.* The following table contains the results of eight experiments as to transverse strength made in exactly the same manner as described in the previous case. The pieces of timber were in all cases carefully selected and accurately dressed. They

* The medullary rays being much less conspicuous in the Coniferæ.

were free from shakes and all other imperfections that might tend to vitiate the results

Letter of Experiment.	NAME OF WOOD.	Specific Gravity.	Greatest Strain.	Effect of Greatest Strain.	Deflection of Greatest Strain.	Deflection with 500 lbs.	Length of Woody Fibre.	Exterior Diameter of Woody Fibre.	Interior Diameter of Woody Fibre	Ratio of Exterior to Interior Diameter.	Duct Area.	Average Annual Growth.
			lbs.			in.	in.	in.	in.		sq in	in.
A	Hickory (Carya porcina, Nutt.)................	.609	1600	Broke.	1.52	.17	.057	.000811	.00036	2.25	.177	.040
B	Hickory (Carya porcina, Nutt.)................	.966	1400	No sign of Breaking.	4.59	.22	.048	.000576	.00012	4.82	.029	.125
D	White Oak (Quercus alba, L.)..................	.706	1500	Broke.	1.08	.40	.056	.000696	.000312	2.23	.189	.047
C	White Oak (Quercus alba, L.)..................	.825	1200	No sign of Breaking.*	4.56	.46	.055	.000699	.000216	3.22	.048	.107
G	White Ash (Fraxinus Americana, L.)............	.615	1750	Broke.	1.08	.29	.047	.000904	.000488	1.85	.222	.063
I	Red Ash (Fraxinus pubescens, Lam.)	.669	1600	Broke.	1.28	.36	.059	.000889	.000512	1.71	.253	.065
J	Chestnut (Castanea vesca, L.).................	.441	900	Broke.	.55	.49	.042	.00104	.000784	1.33	.210	.066
K	Tulip Poplar (Liriodendron Tulipifera, L.).......	.414	1200	Broke.	.94	.24	.058	.001176	.000768	1.58	.333	.061

* Stick bent to support. Hence could bend no further.

Each of the numbers given in the columns headed, Length of Woody Fibre, Exterior Diameter of Woody Fibre and Interior Diameter of Woody Fibre is the average of twenty micrometric measurements. The numbers in the column headed Duct Area represent the area occupied by ducts in one square inch of transverse section. Each of the results there given is the average of planimeter measurement of three camera lucida drawings taken at various parts of a section.

The results of the first four of the above experiments may be summed up thus : *A* and *D stiff* hickory and white oak had small annual growth, moderately large duct area and moderately thick fibre walls ; whereas *B* and *C*, *elastic* hickory and white oak, had moderately large annual growth, small duct area and thick fibre walls. Whether the general difference between elastic and stiff timber is chiefly due to a difference in the character of the cellulose, or whether it is chiefly due to a difference of cell structure is a question that would require a much more extended series of experiments than the above to settle finally. The results given, though too few in number to be of great value, point to the latter view of the case ; while the fact that the same piece of wood will, at various ages, exhibit various degrees of elasticity, inclines us to the former. The experiments *G*, *I*, *J* and *K* show the difficulty of comparing woods of different species. For instance, the pieces *G* and *J* had almost the same annual growth, duct area and fibre thickness. Yet they broke with strains of respectively 1750 lbs. and 900 lbs. An observation that brings out more clearly than before the fact that *differences* of *strength* in woods of *different species* are largely due to *differences* in the *cellulose*.

The measurements of length of woody fibre given in this and in the table of the results of experiments upon the coniferous woods, furnish excellent proof of the correctness of the statement made by Dr. Rothrock, that the relation between the absolute length of fibre and the strength of timber is a very slight one.

The importance of the medullary ray as a strength giving element, though suggested, has not, heretofore, been insisted upon with sufficient positiveness. The following experiments, undertaken with reference to this point, show that in woods such as Oak and Buttonwood, in which the rays are highly developed, a large part of the strength is due to their presence. From cubes of wood, the edges of which measured six inches, plates six inches square and one inch thick were cut in a direction transverse to the woody fibres. From these, pieces of a shape suitable for testing in a cement testing machine were cut, in such a manner that half of the pieces had he medullary rays running in the direction in which the tension was applied, and half of them in a direction perpendicular to this. In each the area subject to strain was one square inch. The result gives, of course, the lateral adhesion of the fibres, with and without the strength added by the medullary rays.

	Live Oak, (*Quercus virens*, Ait.) Lbs.	Red Oak, (probably either *Q. rubra* or *Q. palustris*.) Lbs.
The five pieces tested with the rays running in the direction of the tension broke at	1265 900 1250 960 1225	440 490 480 425 470
Average.......	1120	461
The five pieces tested with the rays running perpendicular to the direction of tension broke at	500 710 480 590 680	245 195 155 190 160
Average	592	189

The surprising fact will be observed that in the Live Oak the force required to overcome the lateral adhesion of the fibres when reinforced by medullary rays is almost, and in the Red Oak more than twice that required when not so reinforced. Similar experiments upon Buttonwood (*Platanus occidentalis* L.) would probably show an equal, if not greater, difference. While Hemlock, Pine, Tulip Poplar or other woods with weak rays, it is but reasonable to expect, would show but slight differences in the two directions.

In view of the above results it is easy to see that resistance to splitting, although usually ascribed to "crookedness of grain," is also in a large measure due to the binding action of the rays. Where, however, we have both of these qualities present, we find a wood admirably adapted for certain purposes, as for example the manufacture of hubs. Hence it is that Rock Elm (*Ulmus racemosa*) and Black Gum or Tupelo (*Nyssa multiflora* Wang.), in both of which abundant rays are found coupled with great contortion of fibres, are much in demand by hub makers. In Lignum Vitæ (*Guaiacum officinale*) the crossing of the fibres of different layers is very apparent, and in a specimen of Black Gum, fibres were found which deviated from the vertical as much as ten times their width in their own length.

Plates III and IV are given as illustrations of the statement concerning resistance to splitting or wedging made above. The upper half of Plate III shows a transverse section of Buttonwood, enlarged 125 times. The drawing is made from the wood of the butt of a tree which portion presented such great resistance to wedging that it was finally reduced to manageable size by the use of gunpowder. In it are seen the abundance

of ducts and great size of medullary ray characteristic of this wood. Below it is placed a transverse section of Tulip-Poplar (same amplification), a wood which splits as easily as Pine. In it the abundance of ducts and weakness of medullary rays are shown. Plate IV gives the same woods, with the same amplification in tangential section, thus cutting the rays transversely and showing the contortion of the fibres in Buttonwood and their straightness in Tulip-Poplar.

To Dr. J. T. Rothrock, for his kind assistance and advice during the preparation of the present article, the writer wishes to express his sincerest thanks. Thanks are also due to Mr. Simmonds, of the University, for his careful preparation of the specimens tested, and to Messrs. Riehlé Bros., upon whose machines the work of testing was performed.

Explanation of Illustrations.

The drawings were all made by the aid of the camera lucida.
In Plate II the amplification is 75 diameters.
In Plate I, III and IV the amplification is 125 diameters.

Plate I, *a*, *Ulmus racemosa.* (Good.)
b, *Ulmus racemosa.* (Bad.)

Plate II, *a*, *Pinus* (sp. ?)
b, *Abies Canadensis.*
c, *Pinus Strobus.*

Plate III, *a*, *Platanus occidentalis*, *b*, *Liriodendron Tulipifera*, } Transverse sections.

Plate IV, *a*, *Platanus occidentalis*, *b*, *Liriodendron Tulipifera*, } Tangential sections

In all the illustrations the following lettering is used:
W F—Woody Fibre.
D—Duct.
M R—Medullary Ray.

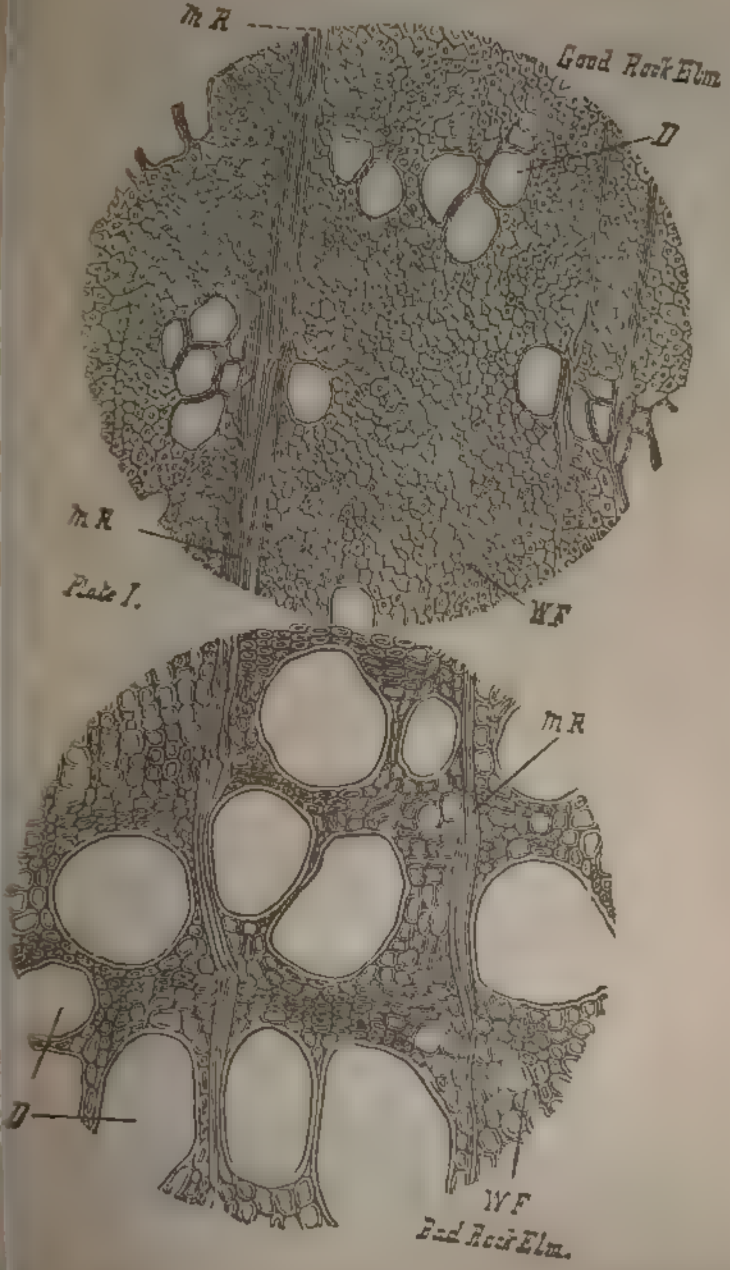


Plate I.

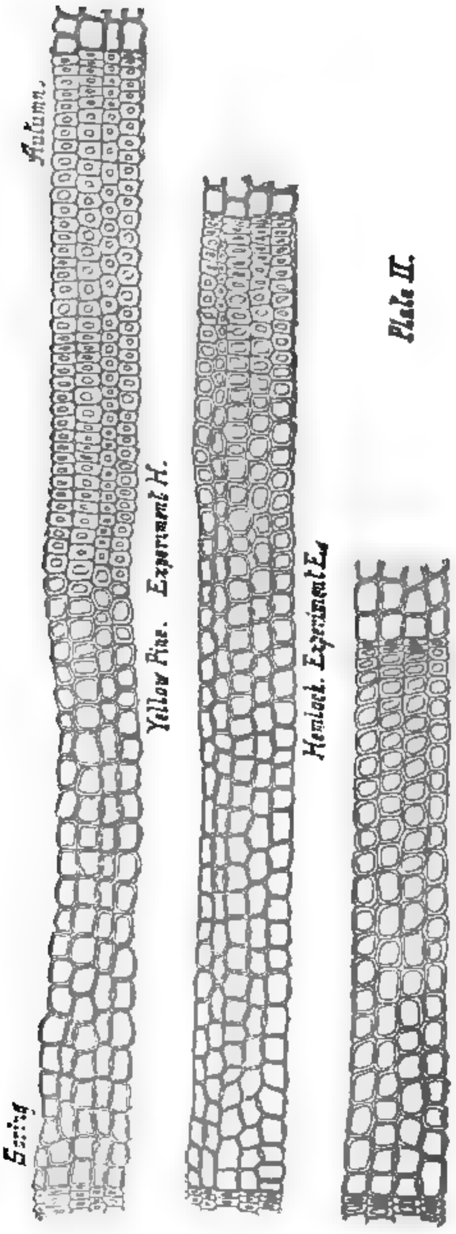
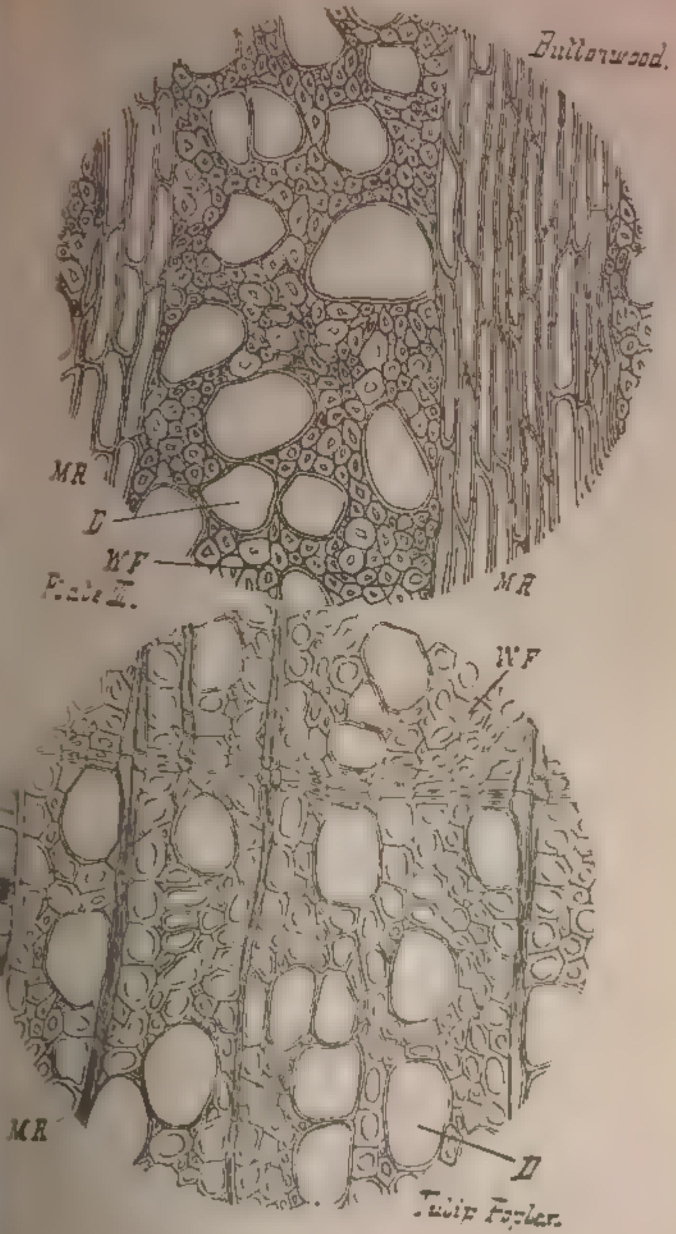
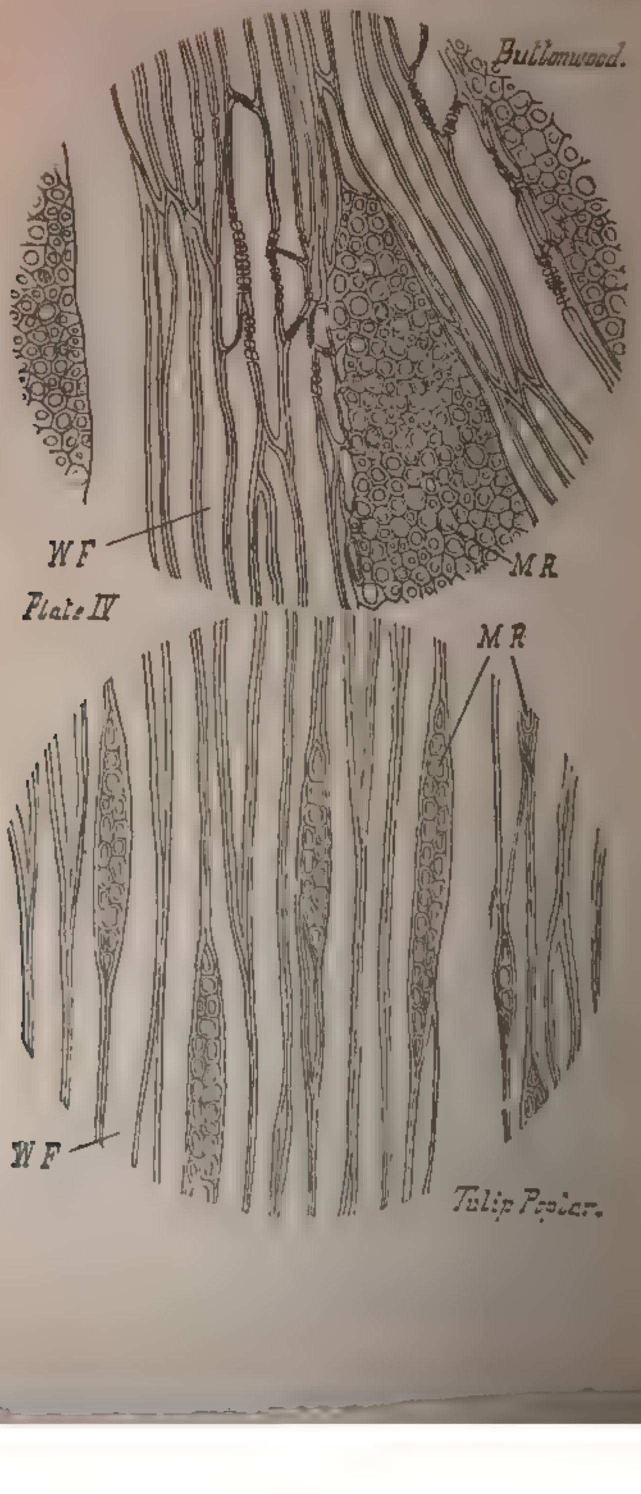

Autumn.
Spring
Yellow Pine. Experiment H.
Hemlock. Experiment E.
White Pine. Experiment L.

Plate II.


Buttonwood.
MR
D
WF
MR
WF
MR
D
Tulip Poplar.


Buttonwood.
W F
M R
Plate IV
M R
W F
Tulip Poplar.

Stated Meeting, January 4, 1884.

Present, 7 members.

President, Mr. FRALEY, in the Chair.

Donations for the Library were received from Captain R. C. Temple, Allahabad; MM. August Berger and Fried. Pressel, Ulm, Prof. Paul Albrecht, Brussels; the Geological Commercial Society, Bordeaux; the Geographical Society and M. Luciano Cordeira, of Lisbon; the Revista Euskara; Revue Politique; Mr. H. M. Stanley; Mr. W. Marriott; Mr. John Hampden; London Nature; Meteorological Society; Royal Astronomical Society, Victoria Institute; Kew Observatory; Royal Geological Society of Cornwall; Mr. F. B. Hough, of Concord, New Hampshire; the Essex Institute; B. N. H. S.; Science Record; Meteorological Observatory at New York; Philadelphia Library Company, Franklin Institute, Mr. Henry Phillips, Jr., United States Fish Commission and United States National Museum.

The death of Sven Nillson, at Lund, November 30, 1883 aged 96 years, 8 months, 22 days, was announced.

The death of General Thomas Leiper Kane, at Philadelphia, December 26, 1883, aged 61 years, 11 months, was announced by Mr. J. S. Price.

The death of General Andrew A. Humphreys, at Washington, December 27, 1883, aged 73 years, was announced by Mr. Fraley, who was, on motion, authorized to select members of the Society to prepare notices of General Kane and General Humphreys.

Mr. Lesley offered to the inspection of the members a photographic print of one of Mr. George Simpson's beautiful drawings of Mr. Mansfield's cannel coal shale specimens, on which is exhibited a nearly perfect specimen of *Dolichopterus Mansfieldi* C. E. Hall (see Proceedings American Philosophical Society, Volume XVI, page 621, 1877), lying across a mass of broken ferns and stems, *Pecopteris*, *Neuropteris*, *Annularia*, *Sigillaria*, &c. Twenty-five figures of Eurypterids, in whole or in part, with enlargements of scales, &c., will be published by the Second Geographical Survey, with the three plates of similar forms from Warren county, drawn and described by Mr. C. E. Beecher.

He exhibited also a *quartz pebble*, with coal adhering to its sides, about the size of a goose egg, found in the floor of Mr. Mansfield's *Cannel coal bed*, at his mines near Cannelton, in Beaver county, Pennsylvania. Four such had been found at different times in the progress of mining this bed. Similar finds have been made in other coal fields in America and in Europe. One very large rock of limestone in the body of a coal bed in Fayette county, Pennsylvania, was reported by Prof. J. J. Stevenson. Such events could only have taken place beneath very slowly running water bearing along upland trees with stones attached to their roots, and dropping these stones one by one into the marsh vegetation through which the water moved.

Mr. Lesley communicated a note, or suggestion, in mythological studies, respecting the original meaning of the animal ideograph of the god *Set*.

Dr. Brinton, Mr. Phillips and Mr. Lesley were appointed a Committee to examine the Mexican manuscripts belonging to the Society, now on deposit with the Academy of Natural Sciences of Philadelphia, to report on the propriety of preparing any of them for publication, and with power to reclaim the same.

Mr. Lesley was nominated Librarian.

The Report of the Judges of the Annual Election was read, by which the following officers were declared duly elected for the ensuing year, 1884:

President,

Frederick Fraley.

Vice-Presidents,

Eli K. Price, E. Otis Kendall, Pliny E. Chase.

Secretaries,

Geo. F. Barker, Daniel G. Brinton, Henry Phillips, Jr., J. P. Lesley.

Counsellors for three years,

Daniel G. Goodwin, W. S. W. Ruschenberger, Henry Winsor, Wm. A. Ingham.

Curators,

Geo. H. Horn, Charles E. Ames, Philip H. Law.

Treasurer,

J. Sergeant Price.

And the meeting was adjourned.

be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve Councillors and other officers of the Society, and having received the report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given by public advertisement) proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then

depending, or who hath not previously declared to the Society that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the Society, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium, for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object, or subject matter of the communications so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure in any year of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accumulation of premiums shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of ——— A.D. ———." And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the Treasurer.

The said fund shall be charged with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The Treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus [illegible] by the Society for making publication of the terms of the said premium, and for the addition to the said premium of such amount as the Society may, from time to time, think suitable, or for the institution of new premiums.

The Treasurer shall, at the first stated meeting of the Society in the month of December, annually make a report of the state of said fund and of the income thereof.

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXI. JANUARY 4 TO MAY 16, 1884. No. 115.

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EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

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3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

A GRAMMAR OF THE CAKCHIQUEL LANGUAGE OF GUATEMALA.

Translated from a MS. in the Library of the American Philosophical Society, with an Introduction and additions,

By Daniel G. Brinton, A.M., M.D.,

One of the Secretaries of the Society.

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INTRODUCTION.

A GRAMMAR OF THE CAKCHIQUEL.

SUPPLEMENT.

INTRODUCTION.

§ I. *The Cakchiquel Nation.*

The Cakchiquel language was, and continues to be, spoken by the natives in the vicinity of the city of Guatemala. It is a dialect of the Maya group of languages, and is very closely related to the Kiche and Tzutuhil dialects, and more remotely to the Chorti, Mam, Pokomam, Ixil, Pokonchi and Kekchi, all yet extant in that part of Central America.

At the time of the Conquest, the Cakchiquels were divided into two States under the senior and junior branches of the same reigning house. The capital of the elder branch was called *Patinamit*, The City, *par excellence*, or *Iximche*, the name of a tree, a species of *Brosimium*, fam. *Artocarpeaceæ*, but it received from the Aztec invaders the name *Tecpan Guatemala*, The Royal House of Guatemala, by which it is usually entered on modern maps. The junior branch had its seat at Zololá, situate on a lofty summit north of Lake Atitlan, a site called by the Aztecs, *Tecpan Atitlan*, the Royal House of Atitlan.* The whole of this district is elevated, and the climate temperate; but there were also a few Cakchiquel colonies in the hot lands near the Pacific Coast, as at Patulul, Cozumelguapam (celebrated for the inscribed slabs lately discovered there) and other places. Here they were in immediate contact with the Pipiles, of Aztec descent, and speaking a slightly corrupted Nahuatl dialect.

As the city of Guatemala was founded in the midst of a Cakchiquel-speaking population, this language early attracted the attention of the missionaries. The first bishop, Francisco Marroquin, appointed to the See in 1534, was himself an earnest student of the tongue, and secured the publication of a doctrinal work in it. When in 1678 the University of Guatemala was formally founded, a chair of the Cakchiquel language was created, the first occupant of which was Fr. José Senoyo, a Dominican. In 1743 Guatemala was raised to the dignity of an Archbishopric, and thereafter it was customary to call the Cakchiquel "the metropolitan tongue," *la lengua metropolitana*, or *la lengua Guatemalteca*. It was regularly taught in the University until the dissolution of the political dependence of Guatemala on the Spanish Crown (1822), since which event, I be-

* For the full explanation of these and other Nahuatl names found in Guatemala, see Buschmann, *Ueber die Aztekischen Ortsnamen*, § VIII.

lieve, no Professor of Cakchiquel has been appointed, and no systematic instruction given in the tongue.

The meaning of the name *Cakchiquel* is obscure. A passage in Herrera gives it the translation, "eagle," with the explanation that it was the name of the site on which the city of Guatemala was founded, and was derived from the custom of the war chief of that nation carrying an eagle as a banner.* The dictionaries, however, do not support this derivation. Evidently Herrera's informant took the name from *cakix*, the ara or guacamaya, *Trogon splendens*, a bird of beautiful plumage, held sacred by most of the Central American tribes. But the derivation is too violent.

The root *cak* means "red," or more correctly, something red; *chi*, is mouth, literally and metaphorically, hence speech, language, dialect; and in such proper names as Pokonchi, Kakchi, etc., it apparently has this latter signification, as the dictionaries translate *Cakchiquelchi* by "the Cakchiquel language." The last syllable *quel*, has been translated "stone," though I do not find this form in the dictionaries, but only the allied ones, *qual*, a term applied to all precious and supposed medicinal or sacred stones, such as were used for amulets, and *qeley*, brick, a connection strengthened by the adoption by some writers of the form *Cakchiqel*.† Dr. Berendt suggested that the three syllables could thus be fairly translated, "The Red Mouth of the Rock," or mountain; the reference being to the active volcanoes whose fiery outbursts have so often desolated that region, and which we know were regarded and worshiped with superstitious veneration.

The natives, however, derived their name from a mythical tree, the *caka chee*, or red tree, which they brought with them from Tullan, their ancient home beyond the sea. This is expressed in the following sentence from the *Annals* of Xahila:

"Xa ka hun chi caka chee ka qhamey ok xoh pe xi qo ka qama pe chu chi Tullan, quereqa ka binaam vi Cakchiquel vinak."

The *Cakachee* is now the name of one of the dye woods which grow in Guatemala.

I have said the language was called *Cakchiquelchi*, and they spoke of

* "La ciudad de Santiago de Guatemala, cuio sitio llamó Cachequil, que significa Aguila, porque el General de esta Nacion, quando salia à la Guerra, llevaba un Aguila por Penacho, etc." Herrera, *Descripcion de las Indias Occidentales*, Cap. XII.

† The anonymous dictionary of the Cakchiquel, lately in the possession of Mr. E. G. Squier, usually gives this form.

themselves as *ahcakchiquels*, but generally by the simpler term *Cakchiqueles*.

II. *History of the Present Work.*

The present Grammar of the Cakchiquel is the translation of a portion of a Spanish manuscript presented to the Library of the American Philosophical Society in 1836, by Señor Mariano Galvez, then Governor of Guatemala, and obtained, it would appear, from the library of one of the religious houses. I have described this MS. in a previous publication, and will transcribe what I have there written :

"The next work is a small quarto of 109 leaves. Unfortunately, the first leaf with the general title is missing. The top of the second leaf commences in the midst of a sentence in a *Doctrina Christiana* in Cakchiquel. This covers ten leaves, and is followed by two leaves of 'Preguntas de la Doctrina,' all in Cakchiquel. Next comes a 'Confessionario breve en lengua Cakchiquel.' The Spanish translation of each question and answer is also given.

"After the Confessionario are three leaves, unnumbered and blank, except that on the recto of the second is a Latin Prayer to the Virgin, difficult to decipher.

"On the recto of the next leaf is the following :

"'*Arte* || *de la lengua cak* || *chiquel.*'

"It is written in a clear small hand, covers fifty-four pages, with an average of thirty lines to the page, sometimes with one column, sometimes with two, and closes with the colophon :

"'Martes á 24 de Junio de 1692 años dia del Nacimiento de S. Juan Baptista se acavo el traslado de oraçiones y Arte en Kakchiquel.'

"From the close of this to the 96th leaf there is another series of doctrinal questions in Cakchiquel.

"Then follows another 'Confessionario breve en lengua castellana y cakchiquel,' 12 pages in length, differing considerably from the previous one. The rest of the volume is taken up with 'Platicas,' short discourses on religious subjects. * * The characters of Parra are employed in all the divisions of the book, and the writing is generally quite legible.

"There is no hint throughout where the original was written nor by whom. * * * The linguistic value of the *Arte* is considerable."*

As no part of the collection presented to the Society by President

**A Notice of Some Manuscripts in Central American Languages*, by Daniel G. Brinton, *American Journal of Science and Arts*, March, 1869.

Galvez, has ever been published, it was resolved at a meeting toward the close of 1883 to have this short grammar translated and printed, and the task was referred to me.

A close examination of the MS. showed that the copyist had not been always accurate, sometimes failing in a consistent orthography, and once or twice having manifestly neglected the observance of the proper order of the original. Where there was no doubt about such negligence, it has been corrected in the translation; but elsewhere the original has been adhered to, even when another disposition of the subject seemed preferable to the translator.

Fortunately, the exhibition of the language could be rendered more satisfactory by the aid of two manuscript grammars in my own library. One of these is that of Fray Benito de Villacañas, a Dominican who died at the Convent of Guatemala in 1610, at the age of 78 years, and who for more than thirty years had been a missionary among the Cakchiquels. His knowledge of the language, therefore, dated back to the first century of the Conquest, and his works represent it in its primitive form. The second Grammar is by Fray Estevan Torresano, and was written shortly after the publication in 1753 of the Cakchiquel Grammar of P. Ildefonso Joseph Flores, and with the especial object of improving and correcting that unnecessarily complicated and ill-arranged book. Torresano's is, I believe, the latest grammar of the Cakchiquel which has been composed, as that of Villacañas is the earliest now in existence, and they therefore offered particularly useful aids in this undertaking.

All these grammars take as their plan that of the Latin or Spanish languages, and apply it to this American dialect. To scientific linguists it is needless to say that this method is quite erroneous, and that it forces American tongues into a form wholly uncongenial to their spirit. But it would have been impossible to have adopted any better system, and at the same time to have maintained the semblance of a translation. Therefore, I have confined myself to an obedience of the plan chosen by the authors I had to follow, trusting that the material furnished for the study of the language will be sufficient to allow the linguist to complete a scheme of its organization and to arrange its elements in accordance with the demands of modern science.

III. *Literature of the Cakchiquel Language.*

The Maya group of languages, of which, as I have said, the Cakchiquel is a member, has several points of peculiar interest. It was the linguistic

expression of one of the most cultivated indigenous races on the continent; it was, and still is, maintained with a singular tenacity; it is largely composed of monosyllabic or dissyllabic roots; and its grammatical construction presents a marked contrast to that of its near neighbor, the Nahuatl (Aztec), and still greater to the native tongues of the United States with which we are most familiar, the Algonkin, Iroquois, Dakota, Muskoki, Cherokee, etc., by its very much more pronounced analytic tendency. The latter trait prevails through all its dialects, though more obviously in some than in others. Especially for the latter reason its examination is important to students of languages, as indicating the feeble development of polysynthesis in an American tongue.

Moreover, the Cakchiquel has been, as I have above intimated, one of the most thoroughly studied of native languages. There is a large body of theological literature extant in it, and several semi-historical works by native writers. Very little of this has been printed. So far as I know the following memoranda show all that has been put to press.

1556. According to Remesal, *Historia de Chiapa y Guatemala* (Lib. III, Cap. VII), there was printed at Mexico in this year a *Doctrina Christiana*, in "the Utlateca language commonly called the Quiche," by order of the first Bishop of Guatemala, Fray Francisco Marroquin. Remesal adds, "although the title of the book sets forth that the work was accomplished with the aid of the friars Juan de Torres, and Pedro de Santos (read, Betanzos), of the Franciscan and Dominican orders respectively, yet this was owing to the humility of the Bishop, who could readily write in the native tongue without their aid, but who was anxious to have the terms used in the translation satisfactory to both orders."

Although no copy of this edition is known to exist, I have no doubt that Remesal was in error when he said that the above work was in the Utlateca or Kiche dialect. Elsewhere he himself says it was in "the language of the country" (*la lengua de la tierra*), which, with reference to Guatemala, would undoubtedly mean Cakchiquel. But the most conclusive evidence is the following title from a work, evidently another edition of the above:

1724. Doctrina Christiana en lengua Guatemalteca: Ordenada por el Reverendissimo Señor Don Francisco Marroquin primer Obispo de Guatemala, y del Consejo de su Magistad, y con parecer de los interpretes de

las Religiones del Señor Santo Domingo y S. Francisco: Frai Juan de Torres y Frai Pedro de Betanzos.

Fronting the above:

Christianoil tzih pa Cakchiquel, qhabal, releçan ahau Obispo Francisco Marroquin; nabei Obispo Cakchiquel, ru poponel Emperador. Qui hu-nam vach erah cakchiquel chi Santo Domingo Santo Francisco, Padre Frai Juan de Torres, Frai Pedro de Betanços.

Colophon:

En Guatemala con licencia de los Superiores, por el B. Antonio Velasco, 1724.

The volume is small 4to, 32 unnumbered leaves, the first 30 in two columns, Spanish in the first, Cakchiquel in the second. The 1st and 2d leaves contain a "Prologo" in two columns, Spanish and Latin; leaves 31 and 32 contain a Declaration of Faith, Act of Contrition, and a Prayer, all in one column and in Cakchiquel only.

The only copy known of this work is in a private collection in Guatemala, and the description given above is from Dr. C. H. Berendt's notes, taken from the book itself. It is not mentioned by any of the bibliographers. I think the title leaves no doubt but that it is a reprint of the *Doctrina* referred to by Remesal, and that he was in error in speaking of it as in the Kiche.

1753. Arte de la Lengua Metropolitana del Reyno Cakchiquel ó Guatemalico, con un Paralelo de las Lenguas Metropolitanas de los Reynos Kiché, Cakchiquel, y Zutuhil, que hoy integran el Reyno de Guatemala. Compuesto por el P. F. Ildefonso Joseph Flores, hijo de la Santa Provincia del Dulcissimo Nombre de Jesus de Guatemala, de la Regular Observancia de N. Seraphico P. S. Francisco, Ex-lector de Phylosophia, Predicador, y Cura Doctrinero por el real Patronato del Pueblo de Santa Maria de Jesus. En Guatemala, por Sebastian de Arebalo, año de 1753. Small 4to, pp. 387.

I take the above title from Squier's *Monograph of Authors who have written on the Languages of Central America* (New York, 1861). The work has now become very scarce, although about half a dozen copies are known to be extant in private hands.

1840. M. Ternaux-Compans in his *Vocabulaires des Pricipales Langues du Mexique*, published in the *Nouvelles Annales des Voyages*, Tome IV, printed about 500 words of the Cakchiquel, taken from an anonymous

MS. dictionary in the National Library, Paris, and accommodated to the French orthography.

1857. Extracts in the original with a French translation from the "Manuscript Cakchiquel ou Memorial de Tecpan-Atitlan" in Brasseur de Bourbourg, *Histoire des Nations Civilisées du Mexique et de l'Amérique-Centrale* (Paris, 8vo). Two pages, in two columns, French and Cakchiquel. The Abbé frequently referred to this document and considered it, with reason, one of the most important extant on the pre-Columbian history of America as well as for its great linguistic value. It was the work of a native Cakchiquel noble, Francisco Ernantez Xahila, who wrote most of it about 1570, and after his death it was continued by a relative, Francisco Gebuta Queh.

1862. Cartilla Breve traducida en Lengua Quiche y Cakchiquel al pié de la Letra para el uso de los Cristianos Indigenas. 2 pp. Pp. VII and VIII of the *Grammaire de la Langue Quichée*, by the Abbé Brasseur de Bourbourg (Paris, 8vo, 1862). The orthography is brought into conformity to French types. The Abbé does not give the origin of this piece. The same volume contains a comparison of the three dialects, Kiche, Cakchiquel and Tzutuhil, and a Vocabulary of Roots common to the three, both derived from the works of Father Francisco Ximenez.

With the exception of a few unimportant vocabularies, by Galindo, Scherzer, and others, and the discussion of the Cakchiquel in general works on language, such as those of Hervas, Pimentel, Lucien Adam, etc., the above includes all the printed material relating to the tongue known to me.*

I should not omit, however, to mention the interesting studies in comparative grammar, which have been made with reference to it and its allied dialects by M. Hyacinthe de Charencey. His observations are based on a critical and conscientious analysis of the hitherto accessible materials, and are aided by an extensive acquaintance with the idioms of the Old World. The articles he has published, and which I name in a note, throw more light on the structure and relations of the whole group of languages

* Since the above was in type, I have received Dr. Otto Stoll's excellent monograph, *Zur Ethnographie der Republik Guatemala* (*Zurich*, 1884), in which, pp. 129–158, he gives a grammatical sketch of the modern Cakchiquel as spoken in the vicinity of San Juan Sacatapequez. He also adds many words and phrases in the tongue.

to which the Cakchiquel belongs, than the production of any other philologist whose writings I have met. Those who would use the present grammar to the best advantage should acquaint themselves with these essays of M. de Charencey.*

The following alphabetic list contains a brief reference to all the writers and works which have been produced in Guatemala in or upon this tongue:

ALARCON, BALTASAR DE. Flourished 1600.

Franciscan. Collected a volume of sermons written in Cakchiquel by various members of his order. In the Brasseur collection.

ALONZO, JUAN. Flourished about 1550.

Native of Guatemala (?). Dominican. Composed a *Calepino* or Dictionary of the Cakchiquel, yet extant.

ANGEL, FR. About 1700.

Franciscan. A Grammar and Dictionary attributed to him were in the Brasseur collection.

BETANZOS, PEDRO DE. † 1570.

Native of Spain. Franciscan. Composed a Grammar and Vocabulary of the Cakchiquel, and prepared, assisted by Juan de Torres, the *Doctrina* printed at Mexico 1556, and Guatemala, 1724, described above.

CORRAL, FELIPE RUIZ. † 1636.

Native of Guatemala. Prepared a Grammar and Vocabulary of the Cakchiquel for the use of the priests.

COTO, TOMAS. Franciscan, 17th century.

Native of Guatemala. He is the author of *Vocabulario de la Lengua Cakchiquel vel Guatemalteca * * En que se contienen todos los modos y frases elegantes con que los Naturales la hablan*, folio, 476 leaves, 2 cols. MSS. in the library of the American Philosophical Society. It is complete down to the word *vendible*, but the last few leaves are missing.

* *Sur les lois phonétiques dans les idiomes de la famille Maya-Quiché.*
Sur le pronom personnel dans les idiomes de la famille Maya-Quiché.
Sur le système de numération chez les peuples de la famille Maya-Quiché.
Recherches sur les noms de nombres cardinaux dans la famille Maya-Quiché.
Sur la langue dite Mame ou Zaklo-pak ap.

These are included in *Mélanges de Philologie et de Paleographie Américaines par le Comte de Charencey*, Paris, Ernest Leroux, 1883, except the last two, which are later and separate publications. I am glad to add that we may expect shortly from the same competent hand a thorough analysis of the verb in this linguistic group.

Delgrado, Damian.

Order of Preachers. Prepared a Grammar and Dictionary of the Cakchiquel.

Flores, Ildefonso Joseph. † 1772.

Native of Guatemala. Franciscan. Professor of Cakchiquel in the University of Guatemala. Wrote the only published Grammar of the tongue, which has already been described.

Guzman, Pantaleon de. Flourished 1700.

Order of Preachers. Cura of Santa Maria de Jesus Pache. Wrote a *Thesaurus Verborum* and a *Doctrina.* A copy of these is in my possession.

Hillon, Joan de.

Dominican. "Maestro gravissimo y mui gran lengua." *Coto.* His works are not known.

Irondo, Juan Francisco.

Native of Guatemala. Franciscan. Wrote in Cakchiquel an *Exposicion del Simbolo de San Atanasio.*

Maldonado, Francisco. Flourished 1640.

This minorite friar wrote a *Ramillete, manual para los Indios sobre la Doctrina Christiana,* and an *Explicacion de la Doctrina Christiana,* copies of both of which, made in 1748, are in the library of the American Philosophical Society, in folio. He is frequently quoted by Coto for the purity of his style.

Marroquin, Francisco. † 1563.

Native of Spain. Franciscan. Bishop of Guatemala, 1533 to 1563. Was the first to reduce to writing the Kiche language. Wrote a Cakchiquel Grammar, and ordered the preparation of a *Doctrina* in that tongue by the Brothers Betanzos and Torres. See above.

Mendoza, Juan. † 1619.

Native of Mexico. Franciscan. Wrote a *Doctrina,* Lives of the Saints, and Doctrinal Sermons in Cakchiquel.

Ordoñez, Diego. 1490–1607 (?).

Born in Spain. Franciscan. Said to have been the first to reduce the Cakchiquel to writing. Composed in it a *Doctrina* and a number of sermons.

Parra, Francisco de. † 1560.

Native of Spain. Franciscan. Devised the five peculiar characters

of the Cakchiquel alphabet, and composed a trilingual vocabulary of Kiche, Cakchiquel and Tzutuhil.

PAZ, ALONZO. † 1610.

Native of Guatemala. Franciscan. Taught Cakchiquel and wrote in it a work entitled *Scala Cœli*, frequently quoted by Coto as an authority.

QUEH, FRANCISCO GEBUTA. 1580.

A native Cakchiquel. Wrote a continuation of the Annals of Xahila, q. v.

RODRIGUEZ, JUAN.

Native of Spain. Franciscan. Composed a Grammar and Vocabulary of the Cakchiquel.

SALCEDO, FRANCISCO.

Native of Chiapas. Franciscan. Professor of native languages in the University of Guatemala. Wrote a Grammar and Dictionary of the Cakchiquel.

SAZ, ANTONIO.

Native of Chiapas. Franciscan. Wrote Sermons in Cakchiquel and an improved Grammar called *Manual en la Lengua*. Also *Manual para los Casados*. His works are often quoted by Coto as models of style.

SOTOMAYOR, PEDRO. † 1631.

Native of Guatemala. Franciscan. Wrote a Grammar, Vocabulary and Sermons in Cakchiquel.

TORRES, JUAN DE. Flourished about 1550.

Native of Spain. Dominican. Assisted by Pedron de Betanzos, he prepared, by order of Bishop Marroquin, the *Doctrina* in Cakchiquel, subsequently printed.

TORRESANO, ESTEVAN. Flourished 1750.

Native of Guatemala. Wrote an improved Grammar of the Cakchiquel, described above. A copy is in the national library of France, and another in my collection.

VAREA, FRANCISCO. Flourished 1600.

Native of Spain. Franciscan. Wrote a *Calepino* or Dictionary of Cakchiquel, a copy of which, made in 1699, by Fray Francisco Çeron, is in the library of the American Philosophical Society. Squier in his *Monograph* erroneously gives his name as *Varela*. The volume is small 4to, 239

leaves in all, closely written, and gives the translation of about 4000 Cakchiquel words.

VICO, DOMINGO. †1555

Native of Spain. Order of Preachers. Composed a Grammar and Vocabulary of the Cakchiquel, and in it some sacred poems, and the celebrated *Theologia Indorum*. A copy of the latter is in the library of the American Philosophical Society.

VILLACAÑAS, BENITO DE. †1610.

Native of Spain. Dominican. Wrote a Grammar and Dictionary, both preserved, and copies of both are in my collection.

VILLEGAS, ANTONIO PRIETO DE. 17th century.

Commissary of the Holy Office. For thirty years *beneficiado* of Matzatenango. Thoroughly versed in Kiche. Wrote *Tratado sobre el Baile Loxtun*. *Coto*.

XAHILA, FRANCISCO ERNANTEZ ARANA. †15(?).

A native writer. Composed the Annals of his nation, the so-called *Memorial de Tecpan-Atitlan*. Copy in the Brasseur collection and another in mine.

XIMENES, FRANCISCO. Flourished 1710.

Native of Spain. Dominican. Wrote a Catechism and Confessionario in Cakchiquel, and a Comparative Grammar of the three dialects, printed by Brasseur de Bourbourg. See above.

To the above should be added various anonymous productions and those whose authors are unknown. Among the last mentioned is the work now printed, to the authorship of which I have obtained no clue.

In the National Library at Paris there is a fine 4to MS., of 202 pp., in Cakchiquel, dated 1553, said to be a translation of the Pentateuch (?). That library also possesses an anonymous *Vocabulario en lengua Castellana y Guatemalteca*, a recent copy of a much older work.

I have in my library a *Calendario de los Indios de Guatemala*, 1685, in Cakchiquel, a copy of an original in the city of Guatemala, and I have heard of other written calendars in various parts of that country.

§ IV. *Phonology of the Cakchiquel.*

The Spanish missionaries complained of the idioms of Guatemala as excessively rough and guttural, *con asperisima pronunciacion gutural*, as the

historian Juarros says.* Nor do they seem to impress recent travelers other nations more agreeably. One of the latest of these, an Englishma writes : "When an Indian speaks, it is always in a high, unmusical tone the language is hideous, and sounds like a person speaking without an roof to his mouth."†

In the present work, as in most that have been written in or upon the Cak chiquel, the phonetic basis is the Spanish alphabet. Of that alphabet the following letters are used with their Spanish values, a, b, c, ç, e, i, l, m, n, o, p, q, r, t, y, z.

The following are not employed :

d, f, g, j, s, ll, ñ

The following are introduced, but with sounds differing from the Spanish :

h. This is always a decided rough breathing or forcible expiration, like the Spanish j, or the strong English h ; except when it follows c or q when it is pronounced as in the Spanish *cha*, *che*, &c

k. This has never the sound of c, but is a rough palatal, the mouth being opened, and the tongue placed midway, between the upper and lower walls of the oral cavity, while the sound is forcibly expelled.

v. This letter whether as a consonant (*v*) or a vowel (*u*) is pronounced separately, except when it is doubled as in *vuh* (*uuh*), book or paper, when the double vowel is very closely akin to the English *w*. The Spanish writers are by no means consistent in their orthography of the Cakchiquel, in distinguishing the vowel *v* and the consonant *v*.

x. In Cakchiquel and its associated dialects, this letter represents the sound of *sh* in the English words *she*, *shove*, etc. It is of very frequent occurrence in all of them.

Besides the above, there are five sounds occurring in the Cakchiquel, Kiche and Tzutuhil, for which five special characters were invented or rather adopted by the early missionary Francisco de la Parra, who died in Guatemala in 1560 They are the following

ꜯ ꜭh ꜭ ɛ ꜫ

* He adds, "y que con solo pronunciar con mas ó menos fuerza las palabras mu- dan de significado." *Compendio de la Historia de la Ciudad de Guatemala* Por el Pr. Don Domingo Juarros, Tomo II, p. 3? 2d ed., Guatemala, 1857).

† *Across Central America* By J. W. Boddam-Whetham, p. 3?4 (London, 187?). The particular dialect he refers to is the Kekchi of Coban in Vera Paz

The origin and phonetic value of these are as follows :

ꜫ This is called the *tresillo*, from its shape, it being an old form of the figure three, reversed, thus, ɛ. It is the only true guttural in the language being pronounced forcibly from the throat, with a trilling sound (*castañeteando*).

ꜭ From its shape this is called the *cuatrillo*, Parra having adopted for it an old form of the figure 4. It is a trilled palatal between a hard *c* and *k*.

ꜯ The name applied to this is the *cuatrillo con coma*, or the 4 with a comma. It is pronounced somewhat like the c with the cedilla, ç, only more quickly and with greater force—*ds ordz*.

ꜩ This resembles the "4 with a comma," but is descibed as softer, the tongue being brought into contact with the teeth.

ꜭh A compound sound produced by combining the quatrillo with a forcible aspirate is represented by this sign.

Naturally, no description in words can convey any correct notion of these sounds. To learn them, one must hear them spoken by those to the manner born.

Unfortunately, there is no uniformity about the use of Parra's signs among the writers in Cakchiquel. Of the considerable number of Cakchiquel MSS. I have examined, I find scarcely two alike in this respect. Most of them use the *tresillo* and the *cuatrillo* ; some discard all of them ; and but few fully carry out the scheme he suggested. The writers differed in nicety of ear, and the same word occurs written in more than one way.

In the printed works no special type has been obtained to imitate these characters. I have some recent publications from Guatemala in the Kiche dialect where the figure three reversed, ɛ, and the figure 4, are employed in the type to represent the tresillo and cuatrillo.* Brasseur used a *g*, and introduced hyphens and apostrophes in his editions of Kiche writings, but these were all foreign to his original manuscripts, and cannot therefore be approved by exact scholarship.

I think there are sound objections to using Arabic numerals to express

* I refer to some songs, etc., in Kiche, published in *El Federal Indiano. Quincenario de antiguedades históricas, costumbres indigenas i jeneralidades*, published at Totonicapam, 1883, by the eminent Guatemalan linguist and antiquary, Señor Don Manuel G. Elgueta.

phonetic elements (though I am aware it has obtained in books printed in Iroquois), and I agree with those who advocate employing rather the European alphabets with diacritical marks. In the present work, therefore, I have concluded to adopt for the tresillo the somewhat similar Greek sigma Σ; and for the cuatrillo the full-faced **q**, this having, indeed, the authority of Varea in his *Calepino* and also of the native writers, Xahila and Queh, who use a modification of this letter for the cuatrillo of Parra. The *cuatrillo con coma* is then readily represented by a full-faced **q**, with a comma, and thus the necessary phonetic distinctions are observed without going beyond the resources of an ordinary printing office, and without presenting to the reader figures or signs which he cannot possibly connect with any sounds whatever.*

* On the general subject of the phonology of the dialects under consideration, the student will find the best information in Dr. C. H. Berendt's essay, *An Analytical Alphabet for the Mexican and Central American Languages* (New York, 1869, published by the American Ethnological Society); and in Dr. Otto Stoll's work, *Zur Ethnographie der Republik Gautemala*, pp. 40-44. The description given in the text of the peculiar sounds is taken from that in Torresano's Grammar.

GRAMMAR OF THE CAKCHIQUEL LANGUAGE.

CHAPTER I. OF THE NOUN.

Declension of Nouns.

The first matter which it is necessary to discuss is the declension of the Noun. In this language there is no declension of cases, as in Latin, as the singular serves for all cases of the singular, and the plural for all cases of the plural. The following rules will explain which nouns have plurals, and which have not:

¶. Every noun which signifies an inanimate thing lacks the plural; as *abah*, stone, *che*, wood, stick, *vleuh*, the earth.

¶. Every noun which signifies an animate thing without other relation or any accident,* has no plural. Such are generic and specific names, as, *chicop*, animal or brute, *tziquin*, bird *quehe*, horse,† *balam*, tiger.

¶. An exception is *yxok*, the female, which makes *yxoki*, the females, and *balam* which is found with the plural *balami*, the tigers.

¶. It is to be noted with reference to these rules that when such nouns are united to the primitive or derivative pronouns of the plural number, then they have a plural, not in expression but in signification. For example, *mani kochoch*, we have no houses; *qo kapop*, we have mats.

¶. When any of the above nouns are united to the primitive or derivative pronouns, in metaphorical expressions, praising or blaming, then they have the plural form; as, *yx quere ak*, you are like hens; *yx quere balami*, you are like tigers.

¶. The nouns referred to in the above two rules also have a plural by union with words signifying plurality, as *qiy*, much, *conohel*, all, and with the ordinal numbers; as *quiyache*, many sticks, *oxivay*, three loaves, *tzatchi vinak*, many people.

* Here used in its metaphysical sense.

† Properly "deer."

¶. Names of animate things which signify an accident of nature as "the young," "the old," etc., or of fortune as "the poor," "the rich," and also participial nouns form their plural by adding to some *a*, and to others *y*; but which termination is to be added must be taught by use. Examples, *mama* the old man, *mamae*, old men; *qahol*, the youth, *qahola*, youths; *aqual*, the child, *aquala*, children; *ala*, the boy, *alabon*, boys; *Σopoh*, the girl, *Σopohiy*, girls; *Σinom*, rich, *Σinoma*, rich people; *meba*, poor, *mebai*, poor people.

¶. Nouns ending in *n* or *m* form their plural in *a*; as *ahticon*, the owner of a cacao plantation, plural, *ahticona*; *ahtziçom*, a tailor, plural, *ahtziçoma*.

¶. Participial nouns ending in *a* form their plural by adding *y*; as *ahtzeola*, the rower, *ahtzeolay*, the rowers; *ahloΣola*, the buyer, *ahloΣolay*, the buyers; *ahpitzola*, he who makes works in feathers, *ahpitzolay* feather-workers. There are some adjective nouns which have a plural form, as *nim*, great, plural, *nimak*; *chutim*, small, plural, *chutik*. To express that a road is lofty or extended, one would say in the singular *naht*, large or extended or distant, and in the plural *nahtik*; *nima ya*, a great river; *chuti ya*, a small river or small rivers.

This particle *he* or *e* added to the noun forms a plural, as *zah he qui Σu*, they have white clothing.

The Grammars of Villacañas and Torresano give some farther particulars of plural forms. The general rule is that nouns denoting inanimate objects have no plurals, and those denoting animate objects are pluralized either by the terminations *a* or *i* (= *y*), or by the use of words conveying plurality. Of the latter the most common is *he* or *e*, which is simply the plural demonstrative pronoun, these or those. This pronoun is also inserted even when the noun has the plural termination, as *Xe be he ah*[illegible] *aki chi cochoch*, the plasterers went to their houses. It carries with it [illegible] specific and definite meaning, and is omitted even with animate nouns [illegible] without plural forms when these are employed in a general sense. Torresano shows this by the following two examples: *conohel he nuqahol xe pa caman*, all my sons have gone to the village cornfield; but, indefinite[illegible] *ronohel vinak xe be pa camah*, all the people have gone to work.

There are also a number of nouns signifying animate objects which [illegible] used absolutely, without the pronominal prefixes, and which may be pluralized by prefixing the *e*. Of these are *tatu*, *tataatz*, or *tataixel*, the father, not stating whose, *qahol*, *qaolatz* or *qaolaxel*, the son, not stating whose[illegible]

hi, hiats, or hiaxel, the son-in-law. These approximate to verbal forms, and appear to be confined to nouns indicating family affinity.

Abstract nouns may be constructed by adding the termination *ah* to the concrete. They do not form plurals, but contain the notion of plurality. Thus, *nu tzam*, is "my nose," but *tzamah*, is "the nose," without reference to person. So Σ*a*, hand, *nu* Σ*a*, my hand, Σ*abah*, the hand, which also means the two hands, as they are always associated in nature.

§ I. *On the Use of Adjectives.*

The adjective noun is always placed first, and then the substantive noun, and between adjective and substantive is placed one of the following particles, which by themselves have no signification:

a, —*y*, —*ilah*, —*olah*, —*lah*, —*ah*, —*olah*, —*vlah*, —*elah*.

Examples: *nim*, large, *nima che*, large stick; q*ij*, much, q*ija* Σ*ul*, much fruit; *çak*, white, *çaki* q*ul*, white cloak; *naht*, high, *nahtik vinak*, great persons; *vtz*, good, *vtzilah ya*, good water; q,*il*, dirty, q,*ilolah* q*ul*, a dirty cloak; *me*Σ*en*, hot, *me*Σ*enalah ya*, hot water; *chaom*, pretty, *chaomalah* Σ*opoh*, a pretty girl; *teu*, cold, *teulah ya*, cold water; q*ay*, bitter, q*aylah ya*, bitter water; *ytzelulah huyu*, a bad descent; *lo*Σ, beloved, *lo*Σ*olah tata*, beloved father; *chu*q,*huh*, maimed, *chu*q,*huhilah ahauh*, a maimed ruler; *xche*, sterile, *xcheelah yxok*, a sterile woman.

¶. Other words add *ic*, as q*ulan*, joined or married, q*ulanic yxok*, a married woman; *hebel*, something pretty and pleasant, *hebelic* q*ul*,* pretty clothing.

¶. Note that when one substantive noun is united to another substantive noun, with the signification of an adjective, one of these particles, *alah* or *ylah*, is placed between them; as *abahilah bei*, a stony road; *gixalah huyu*, a thorny mountain; *chicopilah vinak*, a bestial person.

¶. The particles *elah* and *vlah* are also placed between such substantives, as q,*echelah ticon*, a cacao field neglected and overgrown; *civanilah bei*, a rough road.

¶. And take notice that the least important substantive is placed first, and used as the adjective; as, *gix*, a thorn, *bei*, a road, *gixalah bei*, a thorny road.

* The generic word for clothing is q*ul*; the specific term is Σ*u*; the latter is varied, the former is not. (Coto.)

¶. Observe that when any derivative or possessive pronoun is united to the first noun in such a connection, then one of the following particles is added to the noun, *al, el, il, ol, vl*; as *ahauh*, lord, *rahaual vinak*, the lord of the people: *ru yaalil hoi*, the water of the jar; *ru cheel hai*, the wood of the house; *ru caΣulil che*, or *rua che*, the fruit of the tree; *ru bakil balam*, the bone of the tiger; *ru bohoil cab*, the jar of the honey; *ru popol hai*, the rug of the house. And this is not only the case with third persons, but with all persons, both singular and plural, as:

vahaual Jesu Christo, My Lord Jesus Christ.
auhaual Jesu Christo, Thy " " "
rahaual Jesu Christo, His " " "
kahaual Jesu Christo, Our " " "
yahaual Jesu Christo, Your " " "
cahaual Jesu Christo, Their " " "

To make the above explanation clearer, it should be stated that in Cakchiquel, as in most American tongues, there is no such separate part of speech as an adjective. The word *nim*, does not mean "great," but "a great thing;" *hebel*, "a pretty thing," etc. Such words only assume the sense of adjectives when used to express the quality of a subject. Hence the Spanish grammarians divide the Cakchiquel nouns into the two classes, "adjective nouns," such as the above, and "substantive nouns," which can express being without relation.

Of the terminations *alah, elah, ilah, olah, ulah*, Torresano states that the most frequent are *alah* and *ilah*, as these may be added to almost all nouns, both substantive and adjective; *olah* is used only in the word *loΣolah*.

On the terminations *al, el, il, ol, vl*, Villacañas has the following important remarks: "The possessive pronouns unite with both substantive and adjective nouns, and it is to be noted that when the pronoun conveys the notion of ownership, no termination is added to the noun; but when the pronoun expresses the connotation of a quality or accident, and not ownership, then one of the following particles is added to the nouns, *al, el, il, ol, vl*. For example, *nu uh*, my book, the book which I own; *nu uhil*, my book, that in which matters relating to me are written; *nu colah*, my cord, the cord I own, *nu colobol*, my cord, the cord with which I am bound, etc. When these particles are added to adjective nouns, they express the quality in the abstract, as *zac*, white, *zacil*, whiteness; *vtz*, good *vtzil*, goodness. These abstract nouns can rarely be used with the personal possessive pronouns, although we might say, *nu zacil*, my whiteness."

Chapter II. Of the Pronouns.

¶. There are primitive and derivative pronouns. The primitive are:

yn, I.	*oh*, we.
at, thou.	*yx*, you.
ha,* that one.	*he*,† these.

Other pronouns are: *yn*, *at*, *ha*, *oh*, *yx*, *here*.

Genitives of these words are:

vichin, my or of me.	*kichin*, our.
avichin, thy.	*yvichin*, your.
richin,‡ of that one.	*quichin*, their.

Datives of these genitives:

chuuchin, to or for me.	*chikichin*, to or for us.
chauichin, to or for thee.	*chivichin*, to or for you.
chirichin, to or for that one.	*chiquichin*, to or for those.

The following are datives of the same sense and rendering.§

chue, to or for me.	*chike*, to or for us.
chaue, to or for thee.	*chive*, to or for you.
chire, to or for that one.	*chique*, to or for those.

Accusatives of these words:

chuuh, against me.	*chikih*, against us.
chavih, against thee.	*chivih*, against you.
chirih, against that one.	*chiquih*, against those.

Those words also mean, of or from me, of or from thee, etc.

Torresano adds the explanation: "This accusative has two other significations (besides the one given above). One is 'at my cost,' or 'in my care,' as, 'It is in my care to aid you and to look after you,' *Chuuh qohri ytoow iq'eti nawpe.* The other is, 'behind me,' 'behind thee,' as, 'The garment is behind thee,' *Chahvih qoh vi qul.*" So Coto gives the example: *Chuuh ahilam vi ri,* "This is at my cost or expense."

* Should read *ri*; *ha* is the demonstrative.

† Or, *e*.

‡ Better, *richin*.

§ This form is not given by either of the other grammarians.

In the reciprocal accusative Torresano doubles the terminal vowel, and also adds another form as follows:

chinubil vij, within myself.
chabil avij, within thyself.
chubil rij, within himself.
chikibil kij, within ourselves.
chibil ivij, within yourselves.
chiquibil quij, within themselves.

It is used as in the following example: *qa mahaniok tuinakirioah Dios cah vleuh xaki chubil rij xqohe vi*, Before God created the heaven and the earth He was within Himself. The term *bil* is here used with the possessive pronoun and the preposition *chi*.

In reference to vocatives the same author remarks that they have no peculiar form in this language, and that in place of them they use the second persons, singular and plural, as, *Yx alabon*, Boys, come here (literally, You, boys).

The following accusatives are used in the present tenses:

quin, me.	*koh*, us.
cat, thee.	*quix*, you.
	que, them.

There are other accusatives which are used to form reciprocal verbs, *e. g.*, *tin loΣoh vi;* I love myself; and thus in the other persons prefixing the particles *tin*, *ta*, *tu*, as:

tin—vi, to myself,	*tika—qui*, to ourselves.
ta—avi, to thyself.	*ti—ivi*, to yourselves.
tu—ri, to himself.	*tique—qui*, to themselves.

The ablatives are:

vumal, by or from me.	*kumal*, by or from us.
aumal, by or from thee.	*yumal*, by or from you.
rumal, by or from that one.	*cumal*, by or from those.

There are other ablatives which signify, with me, with thee, etc., to wit:

viquin, with me.	*kiquin*, with us.
aviquin, with thee.	*yviquin*, with you.
riquin, with that one.	*quiquin*, with those.

¶. Possessive pronouns or particles to distinguish the pos-

session of the object; these are, for nouns beginning with a vowel:

v, my.	*k*, our.
av, thy.	*iv*, your.
rr, that one's.	*c*, their.

Thus, *vochoch*, my house, *avochoch*, thy house, *rochoch* that one's house, *kochoch*, our house, *yvochoch*, your house, *cochoch*, the house of those. And in this same way many other nouns are declined, as *vahauah*, my lord, *vahtih*, my master, *vetam*, I know or am acquainted with, an expression used to signify that one knows or understands some art.

The following particles are used with words beginning with a consonant:

nu, my.	*ka*, our.
a, thy.	*y*, your.
ru, of that one.	*qui*, of those.

As, *nuvach*, my face; *avach*, your face; *ruvach*, his face; *kavach*, our face; *yvach*, your face; *quivach*, their face. In the same way the following and many other words are declined:

nutata, my father.	*nuqux*, my heart.
nute, my mother.	*nuquicotem*, my joy.
nuΣahol, my son.	*nughahomonel*, my wash-woman.
numial, my daughter.	*nuhalon tzih*, my false testimony.
nuyavabil, my sickness.	*nutzih*, my word.
nutzik, my clothing.	*nupixa*, my word.
nuqazlibal, my soul.	*numac*, my sin.
nuqazlem, my life.	

All the following nouns are declined by these particles *v* and *nu*:

nunimial, my elder brother.
nuchaΣ, my younger brother.
vana, my sister.
numama, my ancestor.
vatit, my ancestress.

numam viy, my grandchild.
vican nutata, my uncle.
nute, vana, nutata, my aunt.
vicoΣ, my nephew or niece.
qechan, or *nubaluc*, my brother-in-law.
vixnam, my sister-in-law.
vali or *valibatz*, my daughter-in-law.
nu hinam, my father-in-law.
nuhite, my mother-in-law.
nuchaΣ nunahti nimal, my male cousin.
nunahti ana, my female cousin.
nuchi, my son-in-law.
nuyahtata, or, *nutata bal*, my stepfather.
nuyahte, or *nutebal*, my stepmother.

¶. The women say among themselves:

nuxibal, my elder brother.
nughuti xibal, my younger brother.
nunimal, my elder sister.
nuchaΣilatz, my younger sister.
valinam, my father-in-law.
valite, my mother-in-law.
nunahti xibal, my male cousin.
nunahti numal, my female cousin.

The women call the nephew *val* and the niece also, and know if it is a son or not one asks: *Kitzih pe aval?* Is really thy son? If it is she says: *Val*; and if not, *Ralq* *nuxibal*, it is the son of my brother; and of the niece, *Rum* *nuxibal*. *Aval pe?* Is it thy son, or thy daughter? She plies, *Val*, my son.

The following table from Villacañas and Coto exhibits the terms of sanguinity and affinity as used by the two sexes:

	By males.	By females.
my son	*nu qahol*	*val*
my daughter	*nu mial*	*vixokal*
my elder brother	*nu nimal*	*nu xibal*
my younger brother	*nu chaΣ*	*nu qhuti xib*
my elder sister	*vana*	*nu numal*

	By males.	By females.
my younger sister	*nu qhuti vana*	*nu nimalats*
my spouse	*vixhail*	*vachahiil*
my father-in-law	*nu hinam*	*valinam*
my mother-in-law	*nu hite*	*valite*
my brother-in-law	*nu balue, nu hi*	*vechanim*
my sister in law	*vixnam*	*vali*
my son by a former marriage	*nu yah qahol*	*nu yah al*
my daughter by a former marriage	*nu yah mial*	*nu yah izok al*
my male cousin	*nu cha*Σ	*nu nahti xibal*
my female cousin	*nu nahti ana*	*nu nahti nimal*
my grandson	*nu mam*	*viy*
my granddaughter	*nu mam*	*viy*

Many of these are compound words, whose meanings are easily reached: *nimal* is from *nim* or *nima*, large, great; *ghuti*, is small, little; *izok*, female; *xibal*, male; *yah*, the organs of generation of either sex (*nu yah qahol* = the son of thy body); *naht* or *nahti*, remote, distant. *Balue* and *hi* do not mean brother-in-law in our sense, but are applied to all males of the *chinamitl* or *gens* into which the speaker has married. The general word for parentage is *aca*, which is used as in the following sentence: *qoh pe aca quichin qui chiquibil qui vac qulubel?* Is there any relationship between these who are about to marry?

The terms given as used by women only do not in any manner indicate a different linguistic origin It will be seen that several of them are from the word *al*, used above for son and daughter (*izok al* = *female al*); this is a form from *alan*, to bring forth, to give birth to, and is no doubt connected with *al*, a load, a burden, as in English we say of a pregnant woman, "She is carrying" These terms, therefore, must be considered specializations of relationship which are used only by the women because they are from points of view, which, in the nature of things, are peculiar to that sex. Strictly speaking, they are not linguistic peculiarities at all.

These particles, *ri*, *ha*, *hari*, mean "this;" as *ta bana ri*, do this. *Ha* may be used demonstratively as in this sentence, *Ha tahos tiban avumal*, This is proper, that it be done by you. It may also be used for *ille*, *illa*, *illud*; as: *Dios xbana cah vleuh xaviha xbano ronohel q,etom maqui q,etom* (*tzetom*). God made the heavens, the earth, and He made all that we see and do not see. The particle *hari* may stand for *iste*, *ista*, *istud*, as in this example: *Hari vae tzih tavi tibijx chivichin kitzih chi lo*Σ, These words which I speak to you are truly precious. It may also be used for *ipse*, *ipsa*, *ipsum*, as, *Mixcam ri Pedro*,

Pedro has died. *Nakchi Pedro?* Which Pedro? *Hari xa q,et pa bei*, The one you saw in the road.

Other compositions are made with these pronouns in the following manner:

xavi yn ri, I myself.	*xaviohri*, we ourselves.
xavi at ri, thou thyself.	*xavyxri*, you yourselves.
xavi ha ri, that one himself.	*xaviheri*, those themselves.

The following particles carry with them a notion of benefit or of injury. I give an example of benefit: *Xax in vi tool yvichin*, I am the same ally to you as heretofore. Of injury: *Xax in vi agutel*, I am your opponent.

xax in vi, I the same.	*xax oh vi*, we the same.
xax at vi, thou the same.	*xax ix vi*, you the same.
xax ha vi, that one the same.	*xax he vi*, they the same.

Another composition: *vae* means the same as *ecce*, behold; as, *Vae nutzih*, Behold my words; *Vae amac*, Behold your sin.

yn vae, I the same.	*oh vae*, we the same.
at vae, thou the same.	*yx vae*, you the same.
ha vae, that one the same.	*he vae*, those the same.

Thus it is used by one who knows himself and humbles himself: *Yn vae inqazhol, in macol*, I, that same evil sinner.

Another composition is:

yn va, behold me here.	*oh va*, behold us here.
at va, behold thee here.	*yx va*, behold you here.
ha va, behold him here.	*ha va*, behold them here.

As: *Yn va in ahauh*, Behold me here, me, a lord; it is used in pointing out, in this manner, greatness, or wisdom, or strength, or pride.

The particle *ha* placed at the beginning of a sentence corresponds with *vae;* as, *Ha bin ya chavichin vae tin ya*, This is what I have to give you.

QUIS vel QUI. WHO.

Nak and *chinak* signify "who." *Nak ca tux?* Who art thou? *Nak?* Quid est? *Nak achock ychin ri?* or, *Nak ah*

ychin ri? Whose is this? *Nak pe ah ychin?* or, *Nak pe ꝗo rrichin ri?* Whose is this? Or, To whom does this belong? *Nak chiquichin?* To whom? *Nak chiquichin xtin ya vi?* To whom am I to give it? or, To which of them?

Nak chinak, whom or what, to or in whom or what. *Nakchinak chirih ꝗo vi ri mac?* In whom is this sin? *Nak chinak xa camicah?* Whom or what have you killed?

DISTRIBUTIVE WORDS.

He or *hetak* signifies "all" or "every one." These two words are much used, as *Ta ya he* (or, *hetak*) *qui vai vinak alabon ri xtani*, &c., Give bread to each one (or, to all) of the persons, boys or girls, &c. *Ta ya he* (or *hetak*) *qui vuh aꝗuala*, Give the letters to the boys, and to each one of them (the sense of the words being distributive).

vonohel, I all.	*konohel*, we all.
avonohel, thou all.	*yvonohel*, you all.
ronohel, that one all.	*conohel*, they all.

It may be remarked of this word that the first and second pronouns singular are not used, although they say: *Qui be vonohel ꝗuqin e val nuꝗahol*, I shall go with all my people and sons. *Cat be avonohel ꝗuqin eaval eaꝗahol*, Thou shalt go with all thy family. But it is chiefly used with the third person singular and the plurals.

¶. Note, that the third person singular forms the plural, when united to inanimate nouns as: *ronohel yxim*, all the maize; *ronohel abah*, all the stones; and we must not say, *conohel abah*. Further, this third pronoun singular, when added to collective names of plural signification, forms their plurals; as: *ronohel amaΣ*, all the town; *ronohel vinak*, all the people; *kobe ronohel*, we shall all go; *baix bey ronohel*, you shall all go; *que be ronohel*, they shall all go.

Compounds of *quis* or *qui*.

¶. *Naktux*, means who, which or what.
nakchique, which of them.
bilataon, something.
huhunal or *chuhunal*, to each one.

The numeral *hun*, one, is sometimes used for the indefinite article, and at other times as an indefinite pronoun; as, *hun chivichin xqui ya in*, one of you must give me; *hun vinak*, a man. Reduplicated it means each one, as *huhun chivichin xtiqamo hun che*, Each of you must bring a stick. For "somebody," the verb *qoh*, to be in a place, is used, as, *qoh xbano*, somebody did it, i. e.: "There was (who) did it."

The termination *ion*, means "alone," and is used with the possessive pronouns which precede consonants, it being a curious rule which holds good throughout this language that two initial vowels have the phonetic force of a consonant; thus:

nuion, I alone.	*kaion*, we alone.
aion, thou alone.	*yion*, you alone.
ruion, he alone.	*quiion*, they alone.

The negative "nobody" may be formed from *hun*, *manihun*, no one, as, *manihun tibe chi rochoch*, let no one go to his house.

Chapter III. Of the Verbs.

The verbs are rather difficult in this language on account of the variety of their compounds, and their number and diversity, because they have a particular verb for each specific act; thus, to eat, in its absolute sense is *qui va*, I eat, *cat va*, thou eatest, etc. For eating bread they say, *tin vaih;* for eating fruit or eggs, *tin lo;* for eating anything toasted, *tin aix;* for eating vegetables, *tin vechaah*. For this reason the whole difficulty in this language is in learning the verbs and their properties, and therefore something must be said about them, although it is a difficult topic.

There are two kinds of verbs; one kind governs cases and the other does not. All those which govern cases are held to be active, although in the Latin language they may be neuters, or deponents or common. Those which do not govern cases are neuter, and it is necessary to know this, because there are four classes of verbs, active, passive, neuter and absolute. The passive and the absolute are formed from the active verb, so that the active being known, the passive and the absolute can be formed, because, as I say, these are formed from the active.

Sum, es, fui.

In this language there is no proper word to express the verb, and those who up to this time have employed a definite

word have taken that which corresponds to *sto*, *stare*, or to *habeo*, *habere;* for the word ꝗ*oh*, does not mean "to be" (Spanish, *ser*), but "to be in a place" (Spanish, *estar*). To translate this sentence, "I am good," we may not say, *yn* ꝗ*oh utz.* To express all that we say by the verb *sum*, *es*, *fui*, the Indians make use of the following method: They take the primitive pronouns in the appropriate person and number, and place them before any adjective or substantive noun, and thus form the verb; and by various additions and circumlocutions, they express themselves as freely and with as many moods and tenses as we do.

The above statement about the verb "to be" agrees with that in the grammar of Villacañas, but is attacked by Torresano. He writes, "Although other grammarians who have written of this idiom have stated that it does not possess the verb *sum, es, fui,* the contrary is clear enough. In certain tenses the primitive pronouns can be used with the verb *ux*, which, although usually conjugated with the pronouns of the passive voice, may also be conjugated with those of the active, and in that case it has the proper sense of *sum.*"

Father Coto, who has a long note, covering several folio pages, on the rendering of the Spanish verb *ser*, cannot be said to endorse the above. He observes, "This verb *ux* seems to me to correspond in some way to the Latin *fio, fis.*" The word to express the *essentia*, or natural character of a thing, he gives as ꝗ*ohlem*, which is generally strengthened by the affirmative particle *xax* and the correlative *vi*, as *xax* ꝗ*ohlem abah vi*, it is, in its nature, a stone; but it may also mean custom, habit. This was the most appropriate word found in Cakchiquel to express the being of God. The declaration of the persons of the Trinity runs thus: *Quereqa xax oxivi ru vinakil, xaqa hun qui* ꝗ*ohlem, hun navipe Diosil, chi xax huna Dios vi chupam ru* ꝗ*ohlem*, Truly three are the persons, one, the Being (of God), and one, God, and one, God in His Being. This highly abstract expression shows the capacity of the tongue for recondite thought: certainly it is not less clearly put in the Cakchiquel than in any European idiom.

INDICATIVE MOOD.

Present tense.

yn utz, I am good.	*oh utz*, we are good.
at utz, thou art good.	*yx utz*, you are good.
ha utz, he is good.	*he utz*, they are good.

This present is in very common use, and very properly takes

the place of I am, thou art, etc. In phrases of the third person, with a nominative expressed, the *ha* is dropped, as, *utz Pedro*, Pedro is good.

Imperfect preterit.

This tense is formed by adding to the primitive pronoun the particle *naek*.

yn naek utz, I was good.	*oh naek utz*, we were good.
at naek utz, thou wast good.	*yx naek utz*, you were good.
ha naek utz, he was good.	*he naek utz*, they were good.

This is a circumlocution, and to complete its signification a word must be added, as in Latin when we say, *tu eras*— the phrase rests in suspense; hence we must say, *yn naek utz oher*, I was good in past time, thus conveying the sense of an action which was begun but not completed.

Perfect preterit.

The perfect preterit is formed from the present by suffixing a particle of past time, as *oher* or *xueri*, formerly; *yhir*,* yesterday; *cabihir*, day before yesterday, dropping the pronoun in the third person singular.

yn utz oher, I have been good.	*oh utz oher*, we have been good.
at utz oher, thou hast been good.	*yx utz oher*, you have been good.
ha utz oher, he has been good.	*he utz oher*, they have been good.

Pluperfect.

To form this tense the letter *x* is prefixed to theprimitive pronouns and after them is placed the noun; except in the third person of the singular, where the pronoun is not used, but merely the *x*. This tense requires a sentence to follow it, for its explanation, and at its close is placed the particle *vi*; as: *xin utz vi mahaniok cat ul*, I had already been good before thou camest. But the *vi* may also be omitted, as, *xin ulinak*

**Ibir*, Coto.

tok xat ul, I had already arrived when thou camest. Such a use of this tense is quite customary and elegant. Thus to speak of God as a great Lord before heaven or earth was made, we say, *Xaha vi xΣinom vi xtiꝗil vi Dios nimahauh mahaniok tu ban cah vleuh.* Such expressions are aided by a manner of speaking current among those Indians to express nature or habit in anything, although the time is not the same as in the tense we are discussing. Thus they say, *Xax ru çak vi ri ya çak ruach*, This water is by its nature white. *Xax ru ꝗohlem vi ri Pedro nima eleΣom*, Pedro makes a habit of stealing.

Torresano gives several methods of forming the pluperfect, none precisely corresponding with the above. Thus:

hax in vi, I had been.	*hax oh vi*, we had been.
hax at vi, thou hadst been.	*hax ix vi*, you had been.
hax ha vi, he had been.	*hax he vi*, they had been.

Another is

yn ok, I had been.	*oh ok*, we had been.
at ok, thou hadst been.	*yx ok*, you had been.
ha ok, he had been.	*he ok*, they had been.

As, You had been sick when I came, *Ix ok yavai tok xin ul.* It may also be formed by the particles *chi*, *ok*, as, *at fiscal chi ok toxibe*, thou hadst been fiscal when I went; or the particle *chic* may be added, as, *In xax vinak chic tok xat ul*, I had been well when thou camest.

Future Imperfect.

This future is formed from the present by adding the verb *quin ux*, to have become (*ser hecho*).

yn utz xquinux, I shall have become good.

at utz xcat ux, thou wilt have become good.

In the third person the particle *ha* is not used, but the phrase is expressed thus:

utz xtux Pedro, Pedro will be good, or will have become good.

This tense may also be formed by placing at the end an adverb of future time as,

yn utz chuak, I shall be good to-morrow.

Also the particle *chic*, more, may be placed before the said adverb, as:

yn utz chic chuak, I shall be more good to-morrow.

The original omits the future prefix *x* in this tense, but I presume this is a fault of the copyist, and I restore it, following Torresano. He adds this example of its employment. *Ix loΣ xquix ux chire Dios ve tzΣil icii panimac*, You will become the beloved of God, if you abstain from your sins.

Future Perfect.

This tense is formed from the pluperfect by dropping the *vi* and suffixing the adverbial particle *tok*, when, and then the verb; as:

xin utz tok cat ul, I shall have been good when thou wilt have come.

xat utz tok tul Padre, already thou wilt have been good when the Father comes.

For this tense Torresano simply postfixes the particle *chic*, as:

yn nimanel chic, I shall have been obedient.

at nimanel chic, thou shalt have been obedient, &c.

It is difficult to appreciate the precise value of *chic* as a temporal particle. The following examples of its use from the *Calepino* of Varea will illustrate its force: *At mama chic*, already thou art an old man; *xul chic* he had returned; *xcamiçan chic*, he returned again to killing, etc.

Imperative Mood.

The imperative is formed from the present of the indicative by adding the particle *ok* after the pronoun and before the adjective-noun; but in the third person singular the *ha* is not used, and the *ok* is placed after the adjective noun; as

at ok utz, be thou good.

utz ok Pedro, let Pedro be good.

Note that this form of expression is more appropriate where, for example, one asks for a stone and they bring him a stick, and he says, *Abah ok, maqui che*, A stone, I say, and not a stick. They make much use of this verb, *quin ux, cat ux, tux*, which is, in Latin, *fio, fis, fit*, as an imperative, giving it its pronouns and numbers, as,

quin ux, may I become.

cat ux, may thou become.

tux, may he become, and so the rest of the persons, repeating them after the imperative forms, as,

at ok utz cat ux, become thou good.

They also use this imperative thus:

utz ok, let it be well done.
hebelo ok, be it well done.

Also in commands, as *xan ok*, bring bricks, *àbah ok*, bring stones.

Future perfect of future time.

This future is formed from the present of the imperative by the use of one of the following particles: *chiok*, *ꝗateꝗa*, *chui*, *chuhach*, *chirih*, *chupantok*. Thus, to translate the following sentence, Be thou good, after thou shalt have been baptized, *At ok utz kahinak chiok, ru ya Dios pan avi.* Again: Thou shalt be baptized and afterwards thou wilt be made good, *Tï kahna ruya Dios pan avi ꝗateꝗa at utz cat ux.*

Optative Mood.

Present tense.

This tense is formed from the present indicative by inserting the particle *tah* between the pronoun and the noun which follows it, except in the third person of the singular where the pronoun is dropped.

yn tah utz, would I were good!
at tah utz, would thou wert good!
utz tah Pedro, would Pedro were good!
And so on for the other persons.

Torresano observes that there is but one form in this tongue for the optative and subjunctive mood, and he gives the above and the following tenses as subjunctives. He translates the particle *tah* in this connection by *utinam*, but adds that it has other significations. *Si*, if, the subjunctive sign, is *ve* or *veta*, and it will be seen that by its use, and some changes in the particles, our author frames his subjunctive mood.

Imperfect preterit.

This tense may be formed by adding to the present of this mood the particle *tok* and adding what sentence we wish, as: *Yn tah utz tok xirah oqueçax chi ahauarem*, oh, would I had been good when they wished to make me cacique!

It will be noticed that the author directs this and the following tense to be formed alike. This is no doubt an error of the copyist. Torresano forms the imperfect preterit by adding *quin ux*, as, *yn tah naonel quin ux*, I should be understood; and the perfect preterit by repeating the primitive pronoun and adding the perfect particle *inak:*

yn tah mitih in ux inak, I should have been careful.

Preterit perfect.

This tense is formed from the present of this mood by adding the particle *tok*, and afterwards the sentence that we wish, as in the preterit imperfect. Example: *Yn tah utx tok xin ul vave*, oh, if I had been good when I came here!

Preterit pluperfect.

This tense is formed by the present by prefixing to the pronoun the letter *x*, and beginning the following sentence with *tok*, as *xin tah utz tok xul ru tzih Dios*, oh, if I had been good when the word of God came! *Xatah ahau tok xin ul vave*, oh, if thou hadst been ruler when I came here! *Xahau tah Pedro tok xibe*, oh! if Pedro had been ruler when I went away!

Torresano forms this tense by prefixing the particle *xatavi* (x + ha + tah + vi) to the pronoun.

xatavi xin nimanel, would I had been obedient!

Future.

This is formed from the present in the same manner, by adding some particle of future time, as *chic*, *chuak*.

Torresano prefixes *veta*, if, and adds *ux*, as:

veta in nimanel quin ux, if I shall be obedient.

Subjunctive Mood.

Present.

The present of this mood is formed from the present of the indicative by prefixing the particle *vetah*, as: *Vetah yn utzilah christiano qui be chi cah*, if I be a good Christian, I shall go to heaven. Note that a common use of this tense is in sentences like the following: If I were a sinner, I would say that I am

but it is not true that which they charge me with, *Vetah yn ahmac xquichatah, xaka maqui quere xa tan tih atox chirih.*

Preterit perfect.

This tense may be consistently formed like that of the optative by dropping the *tah* and putting in its place *ve;* as: *Ve yn utz tok, qui cam mani tin xibih vi rumal Diablo,* If I should have been good, when I die I shall not fear about the Devil.

Preterit pluperfect.

This tense is like the optative, dropping the *tah* and putting in its place *ve* or *vetah,* as, *Vetah xax yn Σinom vi chila Castilla, maqui tah xin ul vave,* If I had been rich there in Castile, I should not have come here. *Vetah xax at vi ahauh, maqui tah quere catzihon vi,* If thou hadst been ruler, thou wouldst not speak in this manner.

Future subjunctive.

This tense is formed from the present by adding some adverb of time or some verb referring to the future, as, *Vetah yn utz, quin ux xavi cat utzir vmal,* If I shall be good, let it make thee good.

Infinitive Mood.

This is formed by a circumlocution, taking the present of the optative and varying it with the verb *tivaho,* I wish, *tavaho,* thou wishest, etc. Thus, *yn tah utz tivaho,* I wish to be good, etc. The Indians also use many other methods of speaking in this mood, as

utz tah nuqux tivaho, I wish to have a good heart.
utz tah nuqohlem tivaho, I wish to have a good life.
utz tah qui qohe tivaho, I wish to be in peace.
quinutzir tah tivaho, I wish to be good.
tirah tah nuqux yn tah utz, I wish that my heart may be good.
yn tah hebel, to be handsome.
yn tah chaom, to be beautiful.

The preterit can use the adverb *oher* or the others already mentioned, as, *Tivaho tah nuqux yn tah uts oher*, I wish to have been good formerly or in past time.

Future.

This tense is formed by placing the verb *quin ux*, before the desiderative verb, as, *at tah utz cat ux, tavaho*, Thou hast a desire to be good. It may also be formed in other ways, as, *Tiaho tah nugux yntah utz, quinux*, My heart wishes me to be good; or, *Yn tah nuqohlem, tivaho; yntah utz huna caba, yntah utz chic tivaho.*

¶. *Note.* As there is no proper word for this verb in any of its moods, tenses or persons, but it must be expressed by circumlocutions, its translations are numerous; and this is not surprising; it is enough to say that although there is no proper word for it, every one of its forms found in the Latin can be rendered into this tongue.

The verb *cat ux*, in the second and third persons singular and plural, may be used to ask questions, like *sum, es, fui;* as: *Nak cat ux?* Who art thou? Answer, *Yn*, I. Asking again, *Nakchi at?* Who art *thou?* Answer, *Yn Pedro.* So in thep lural, *Nak qui xux?* Who are you? When, seeing a person, the question is asked, *Nak cat ux?* Who art thou? it is equivalent to *Nak atah chok chinamitl?* Of what clan or lineage art thou? To ask, What wood is this? we say, *Nak che el vi?* and to ask of what dignity or position is this man, we say, *Nak ri kalem ri vinak?*

After a similar attempt to render into Cakchiquel the Spanish verb *ser* in its different forms—an attempt which is evidently out of place, as it has no correspondent in the tongue—Torresano translates the conjugation of the Spanish *estar*, in which he succeeds better, as that is properly translated by the Cak. q*oh*. I will give the first persons of the tenses with their Spanish equivalents, the Spanish grammar being richer in flexions than the English.

Indicative Mood.

Present: *tan in qoh*, yo estoy.
Preterit Imperfect: *xtan in qoh*, yo estaba.
Preterit Imperfect Negative: *xtan in qohmani*, yo no estaba.
Preterit Perfect: *xi qohe*, yo estuve.

Preterit Pluperfect: *yn ok qohevinak chic*, yo habia estado.
Future Imperfect: *xqui qohe*, yo estaré.
Future Perfect: *yn qoh chic*, yo habré estado.

Imperative Mood.

cat qohe, está tu.

Optative and Subjunctive Mood.

Present, *qui qohe tah*, yo esté.
or, *ve qui qohe*.
Preterit Imperfect, *xqui qohetah*, yo estaria.
Preterit Pluperfect, *xiqohe tah*, yo hubiese estado.
or, *veta xiqohe*, si yo hubiese estado.
or, *veta in qohevinak*.
Future, *veta xqui qohe*, si yo estuviera estado.

Infinitive Mood.

Present, *tan tivah qui qohe*, yo quiero estar.
Preterit Perfect, *xivao xi qohe*, quisé estar.
Future, *xtivaho qui qohe*, querré estar.

Gerunds.

Genitive, *qui qohebic*, para que yo esté.
Dative, *hata qui qohevi*, para que yo esté.

Participles.

Present, *qoh*, el que está.
Future, *qohlel*, el que ha de estar.

As I have already stated in the Introduction, this arrangement, on the plan of the Latin grammar, is forced, and violates the spirit of the Cakchiquel, as it would of all other American tongues.

On the Conjugation of the Verbs.

Active Verbs.

As has been already said there are four kinds of verbs in this language, active, passive, absolute and neuter.

The verb never varies its termination in any mood or tense. The mood and tense are distinguished by certain particles which in some tenses are placed at the beginning, in others at the beginning and end of the verb.

Active verbs are of two kinds, those which begin with a consonant, and those which begin with a vowel; and each of these has its appropriate particles to distinguish the number, person and tense.

The particles of active verbs, both of one or more syllables, which begin with a consonant are:

tin or tinu, I.
ta, thou.
tu, that one.
tika, we.
ti, you.
tiqui, they.

The form *tinu* for the first person is rarely used in the present, but more frequently in the future.

Present tense.

ti ban, I do.
ta ban, thou dost.
tu ban, he does.
tika ban, we do.
ti ban, you do.
tiqui ban, they do.

All the verbs of this class, of one or several syllables, are conjugated in like manner; as, of one syllable:

tin ya, I give.
tin ꝗ'*et*, I see.
tin ꝗ*am*, I seize.
tin tak, I send.
tin yak, I lift.
tin piz, I wrap.
tin tiz, I spill.
tin quir, I untie.
tin too, I aid.
tin toh, I pay.
tin Σat, I cut.
tin ꝗ*at*, I burn.

Of several syllables; as:

tin loΣoh, I love.
tin bijh, I say.
tin rapah, I whip.
tin tihoh, I teach.
tin qahicah, I flog.
tin ꝗ*utuh*, I ask.
tin chahih, I keep.
tin ꝗ,*apih*, I shut.
tin chomiricah, I direct.

And many others of one or more syllables.

Preterit.

The particles for the preterit of both these classes of verbs are,

xin or *xinu*, I.
xa, thou
xa, that one.
xka, we.
xi, you.
xqui, they.

The forms *xin* or *xinu* are used indifferently by the natives.

Perfect preterit.

xin ban, I have done.	***xka ban***, we have done.
xa ban, thou hast done.	***xi ban***, you have done.
xu ban, that one has done.	***xqui ban***, they have done.

And so of all the above verbs of one or many syllables.

xin *ya*, I have given.	***xin*** *piz*, I have wrapped.
xin **q**,*et*, I have seen.	***xin*** *tiz*, I have spilled.
xin **q***am*, I have seized.	***xin*** *quir*, I have untied.
xin *tak*, I have sent.	***xin*** *too*, I have aided.
xin *yak*, I have lifted.	***xin*** **q**,*at*, I have burned.

And also,

xin *loΣoh*, I have loved.
xin *bijh*, I have said.
xin *rapah*, I have whipped.
xin *tihoh*, I have taught.
xin **q***ahiçah*, I have flogged.
xin **q***utuh*, I have asked.
xin *chahih*, I have kept.
xin **q**,*apih*, I have shut.
xin *chomiricah*, I have directed.

Pluperfect.

To form the pluperfect the particle *inak* is suffixed to the perfect as,

xin ban inak, I had done.	*xka ban inak*, we had done.
xta ban inak, thou hadst done.	*xi ban inak*, you had done.
xu ban inak, that one had done.	*xqui ban inak*, they had done.

Future imperfect.

To form the future imperfect, the particle *x* is prefixed to the present tense.

xti ban, I shall do.	*xtika ban*, we shall do.
xta ban, thou wilt do.	*xti ban*, you will do.
xtu ban, he will do.	*xtiqui ban*, they will do.

And so all these verbs, whether of one or more syllables: *xtin ya*, I shall give, *xtin* ɋ*,et*, I shall see, *xtin loΣoh*, I shal, love, etc.

Future perfect.

This tense is formed by prefixing the following particles, *nu*, *a*, *ru*, and suffixing the adverb *chic*.

nu ban chic, I shall have done.
a ban chic, thou wilt have done.
ru ban chic, he will have done.
ka ban chic, we shall have done.
y ban chic, you will have done.
qui ban chic, they will have done.

This future is also formed with the particles, *v*, *av*, *rr*, as,

*va*ɋ*axah chic*, I shall have heard.
*ava*ɋ*axah chic*, thou wilt have heard.
*ra*ɋ*axah chic*, he will have heard.
*ka*ɋ*axah chic*, we shall have heard.
*yva*ɋ*axah chic*, you will have heard.
*qui a*ɋ*axah chic*, they will have heard.

Another future is formed by the particles of the present and the suffix *na*.

xin loΣoh na, I shall have loved.
xa loΣoh na, thou wilt have loved.
xu loΣoh na, he will have loved.
xka loΣoh na, we shall have loved.
xi loΣoh na, you will have loved.
xqui loΣoh na, they will have loved.

These tenses are conjugated both with the primitive and derivative pronouns; as,

yn loΣon inak, I had loved.
at loΣon inak, thou hadst loved.
ha loΣon inak, he had loved.
oh loΣon inak, we had loved.
yx loΣon inak, you had loved.
he loΣon inak, they had loved.*

* Either an error of the copyist for *yn loΣoh inak*, etc., or an euphonic change.

And so, *yn ban inak*, I had done.
yn rapan inak, I had whipped, etc.

¶. The particle *tan* prefixed to the present of all verbs, active, passive, neuter or absolute, carries the notion of present action of the verb, as,

tan ti ban, I am doing.
tan ta ban, thou art doing.
tan tu ban, he is doing.
tan tika ban, we are doing.
tan ti ban, you are doing.
tan tiqui ban, they are doing.

And so,

tan ti bijh, I am saying.
tan tin ya, I am giving.
tan tin loΣoh Dios, I am loving God.

¶. Particles for active verbs which begin with a vowel. These are for the present tense, *tiv*, *tau*, *tir*, *tik*, *tiu*, *tic*.

tivaho, I wish.	*tikaho*, we wish.
tavaho, thou wishest.	*tiuaho*, you wish.
tiraho, he wishes.	*ticaho*, they wish.

And so,

tivetamah, I know (*cognosco*).
tivoquiçah, I obey.
tivuqaah, I carry.
tivaqaxah, I hear.
tivulicah, I cause to come.
tivutziricah, I bless.
tivätiniçah, I cause to bathe.
tiveleçah, I take out.

¶. The particles for the preterit of these verbs beginning with a vowel are: *xiu* or *xu*, *xau*, *xr*, *xk*, *xiu*, *xc*; as,

xivaho, I wished, or, have wished.
xauho, thou " "
xraho, he " "
xkaho, we " "
xivaho, you " "
xcaho, they " "

So also,

xivetamah, I knew, or, have known.
xiuaqaxah, I heard, or have heard.
xiuuqaah, I carried, or, have carried.

The pluperfect is formed from the perfect by adding the particle *inak:*

xiu aqaxah inak, I had heard.
xau aqaxah inak, thou "
xr aqaxah inak, he "
xka aqaxah inak, we "
xiu aqaxah inak, you "
xca aqaxah inak, they "

¶. The following particles are used with neuter, absolute and passive verbs, which begin with a vowel, *quin*, *cat*, *t*, *koh*, *quix*, *que:*

quin ul, I come.	*koh ul*, we come.
cat ul, thou comest.	*quix ul*, you come.
tul, he comes.	*que ul*, they come.

Again,

quin uquia, I drink.	*koh uquia*, we drink.
cat uquia, thou drinkest.	*quix uquia*, you drink.
tuquia, he drinks.	*que uquia*, they drink.

And so,

quinuxlan, I rest.	*quinoΣ*, I weep.
quinoc, I enter.	*quinoΣeh*, I weep for something.
quinel, I go out.	

The particles which are used for the preterits of these verbs are, *xin*, *xat*, *x*, *xoh*, *xix*, *xe;* as:

xinul, I came, or, have come.	*xohul*, we came, or, have come
xatul, thou, " "	*xixul*, you, " "
xul, he, " "	*xeul*, they, " "

And so,

xinuquia, I drank.	*xinel*, I went out.
xinuxlan, I rested.	*xinoΣ*, I wept.
xinoc, I entered.	*xinnoΣeh*, I wept for something.

The pluperfect is formed by adding the particle *inak* to the perfect; as,

xinul inak, I had come.	*xohul inak*, we had come.
xatul inak, thou "	*xixul inak*, you "
xul inak, he "	*xeul inak*, they "

¶. The following are the particles used with passive, neuter, and absolute verbs which begin with a consonant: *qui*, *cat*, *ti*, *koh*, *quix*, *que*, as,

quipe, I come.	*kohpe*, we come.
catpe, thou comest.	*quixpe*, you come.
tipe, he comes.	*quepe*, they come.

Again,

qui be, I go.	*koh be*, we go.
cat be, thou goest.	*quix be*, you go.
ti be, he goes.	*que be*, they go.

Another,

qui va, I eat.	*koh va*, we eat.
cat va, thou eatest.	*quix va*, you eat.
ti va, he eats.	*que va*, they eat.

Again,

qui var, I sleep.	*koh var*, we sleep.
cat var, thou sleepest.	*quix var*, you sleep.
ti var, he sleeps.	*que var*, they sleep.

And others, such as,

quixuque, I kneel.
qui biçon, I am sad.
quiqaze, I live.

The particles for the preterit are: *xi*, *xat*, *x*, *xoh*, *xix*, *xe*.

xipe, I came or have come.	*xohpe*, we came or have come.
xatpe, thou "	*xixpe*, you "
xpe, he "	*xepe*, they "

And

xibe, I went or have gone.	*xohbe*, we went or have gone.
xatbe, thou " "	*xixbe*, you " "
xbe, he " "	*xebe*, they " "

And

xiva, I ate, or have eaten.	*xohva*, we ate or have eaten.
xatva, thou "	*xixva*, you "
xva, he "	*xeva*, they "

So also,

xivar, I slept, or have slept.
xixuque, I kneeled, or have kneeled.

The verb *vah* is a neuter and means "to wish."

quivah, I wish.	*kohvah*, we wish.
catvah, thou wishest.	*quixvah*, you wish.
tivah, he wishes.	*quevah*, they wish.

Thus,

quiquicot, I rejoice.	*kohquicot*, we rejoice.
catquicot, thou rejoicest.	*quixquicot*, you rejoice.
tiquicot, he rejoices.	*que quicot*, they rejoice.

The verb q*oh*, to be in a place (Span. *estar*).

yn q*oh*, I am.	*oh* q*oh*, we are.
at q*oh*, thou art.	*yx*q*oh*, you are.
ha q*oh*, he is.	*he* q*oh*, they are.

The following convenient presentation of the verbal particles is taken from Torresano's Grammar:

Verbal Particles.

1. For active verbs which begin with a consonant:

For the Present Imperfect and Future.

1. *tin* — *loΣoh.* *tika* — *loΣoh.*
2. *ta* — *loΣoh.* *ti* — *loΣoh.*
3. *tu* — *loΣoh.* *tiqui* — *loΣoh.*

The particles are used in the Present with the prefix *tan*: in the Future with the prefix *x*, and in the Imperfect by prefixing *x* to the Present, as *tan tin loΣoh*, I love, *x tin loΣoh*, I shall love; *x tan tin loΣoh*, I was loving.

For the Perfect.

1. *xin* — *loΣoh.* *xka* — *loΣoh.*
2. *xa* — *loΣoh.* *xi* — *loΣoh.*
3. *xu* — *loΣoh.* *xqui* — *loΣoh.*

The particle *mi* is prefixed to these when the action is recent; *xin loΣoh*, I have loved; *mi xin loΣoh*, I have recently loved.

2. For active verbs which begin with a vowel:

For Present, Imperfect and Future.

1.	*tin*	*oqueçah*, believe.	*tik*	*oqueçah.*
2.	*tau*		*tiv*	
3.	*tir*		*tic*	

The same prefixes are used, *tan tin oqueçah*, I believe; *xtan tin oqueçah*, I was believing; *xtin oqueçah*, I shall believe.

For Perfect.

1.	*xin*	*oqueçah.*	*xk*	*oqueçah.*
2.	*xau*		*xiv*	
3.	*xr*		*xo* or *xqu*	

3. Particles for absolute, passive and neuter verbs.

For Present, Imperfect and Future.

1.	*quin* or *qui*,	*be*, go.	*koh*	*be.*
2.	*cat*		*quix*	
3.	*c* or *h*		*que*	

To these *tan* is to be prefixed for the Present, *xtan* for the Imperfect, and *x* for the Future.

For Perfect.

1.	*xin*	*be*, have gone	*xoh*	*be.*
2.	*xat*		*xix*	
3.	*x*		*xe*	

As in active verbs, the particle *mi* may be prefixed to these to denote recent past time (the Preterit Proximate).

6. The rules for the formation of absolute and passive verbs from active verbs of several syllables are as follows: The verb, *loΣoh*, for instance, drops the final *h* and takes in place of it *n*, and thus forms the absolute verb. This form may be used without an object, as *qui loΣon*, I love, not saying whom. But when the pronouns *yn*, *at*, etc., are prefixed, it has the force of the active, as *yn loΣon Dios*, I love God; *yn quirrapan alabom*, I whip the boys. This is the general rule for all active verbs of several syllables.

7. Passive verbs are formed from active verbs of more than one syllable by dropping the *h* and substituting *x*, as *qui loΣox*, I am loved. After this form the ablative of the person must be used, as *qui loΣox rumal Dios*, I am loved by God; *qui rapax rumal vahtih*, I am whipped by my master. This is

also the formation of the passive in verbs of several syllables which begin with a vowel, as *quinaqaxan*, I hear, *quinaqaxax*, I am heard.

¶. Active verbs of only one syllable form their passives in two manners.

The first is to drop the particles of active verbs, which are, *tin*, *ta*, *tu*, etc., and substitute those of neuter verbs which are, *qui*, *cat*, *ti*, etc., as,

tin ban, I make.	*qui ban*, I am made.
tin ya, I give.	*qui ya*, I am given.

And so with all verbs of one syllable.

The second form of the passive is by adding the particle *tah* to the verb preceded by a vowel like that in the verb, as, *banatah*, *yatah*, etc.

The Imperative.

All verbs of one syllable or vowel if it is *a*, *e*, or *i*, form their imperative in *a* in both singular and plural, e. g.,

tiban, I do; imper. *tabana*, do thou; pl. *tibana*, do you.

tinq,et, I see; imp. *taq,eta*, see thou; pl. *tiq,eta*, see ye.

tin quir, I untie: imp. *taquira*, untie thou; pl. *tiquira*, untie ye.

tin piz, I wrap; imp. *tapiza*, wrap thou; pl. *tipiza*, wrap ye.

Those of one syllable with the vowel *o* form their imperative in *o*, as,

tin bot, I wrap up; imp. *taboto*, wrap thou up; pl. *tiboto*, wrap ye up.

tin cot, I scrape; imp. *tacoto*, scrape thou; pl. *ticoto*, scrape ye.

tin loΣ, I buy; imp. *taloΣo*, buy thou; pl. *tiloΣo*, buy ye.

Those of one syllable with the vowel *u* form their imperative in *u*; as:

tinqut, I appear: imp. *taqutu*, appear thou: pl. *tiqutu*, appear ye.

tinchup, I quench; imp. *tachupu*, quench thou; pl. *tichupu*, quench ye.

But if the verb is of more than one syllable, the imperative has the same form as the indicative, and one of these particles,

is added: *tah*, *taoc*, or *oc;* and these particles can follow all verbs, active, passive, neuter and absolute. In this case no vowel is added to the verb. For example, *taban tah*, *taban taoc*, *taba noc*, do thou. This form is deprecative, rather asking than commanding.

The pronouns *ru*, first person singular, and *ka*, first person plural, are often used with active verbs instead of these particles. For example: *Nuq,eta na missa*, *qateqa quibe*, Let me first see the mass, and then I shall go. *Ka Σihala na xoΣohauh Sancta Maria*, *qateqa tin bijh ru qohlem sancto*, Let us first salute the queen, Holy Mary, and then we shall speak of the saint.

Another imperative and prohibitive is formed by dropping the first letter of any one of the above mentioned particles, and substituting the letter *b* or *m;* as, *baban*, do it not; *machup*, do not quench it. In this case no vowel is added to active verbs of one syllable, but the simple form of the verb is used, whether it be active, passive, neuter or absolute.

Optative Mood.

The particles of the optative mood are the same as those of the indicative, with the addition of the particle *tah;* as: *tin loΣotah*, would I loved God! *xin loΣotah*, would I had loved God!

The particle *tah* is also placed after the particle of present time *tan*, and before the verb; as, *tan tah tinu q,et nu tata*, would I could see my father now!

Subjunctive Mood.

The particle *vetah* is used for this mood; as, *vetah tin loΣoh Dios*, *qui loΣox rumal Dios*, If I loved God I should be loved by God.

Infinitive Mood.

This is formed in a variety of ways.

The first is by taking the verb *tirah*, he wishes, preterit *xrah*, in the third person, without variation, and for the subject the pronouns *nu*, *a*, *ru*, or, if the verb begins with a vowel, *v*, *au*, *r;* and then the active verb, and not a passive or neuter; as, *tirah nu loΣoh Dios*, I wish to love God.

But if the sentence includes any of those accusatives above mentioned, to wit, *quin*, *cat*, *koh*, *quix*, *que*, the infinitive is formed by placing first this accusative, next, the verb *rah* without any particle, then the pronouns *nu*, *a*, *ru*, or, if the verb begins with a vowel, *v*, *au*, *r*, and lastly the active verb; as, *cat rah nu loΣoh*, I wish to love thee.

¶. Note that if the verb *tirah*, *rah*, is followed by a passive, neuter or absolute verb, then this verb *tirah*, is to be conjugated with the particles of the neuter verb; as

qui rah, I wish.	*koh rah*, we wish.
cat rah, thou wishest.	*quix rah*, you wish.
ti rah, he wishes.	*que rah*, they wish.

It agrees in number and person with the person who acts, and is followed by the passive, neuter or absolute verb without a particle; as,

qui rah var, I wish to sleep.	*koh rah var*, we wish to sleep.
cat rah var, thou wishest to sleep.	*quix rah var*, you wish to sleep.
ti rah var, he wishes to sleep.	*que rah var*, they wish to sleep.

Another method of forming the infinitive is by taking the verb *tivaho*, I wish, and then placing the active, passive or absolute verb with its pronoun in number and person, as,

tivaho tin loΣoh Dios, I wish to love God.
tavaho ta loΣoh Dios, thou wishest to love God.
tivaho qui var, I wish to sleep.
tavaho cat var, thou wishest to sleep.
tiraho ti var, he wishes to sleep.
tikaho koh var, we wish to sleep.
tivaho quix var, you wish to sleep.
ticaho que var, they wish to sleep.
tivaho qui loΣox, I wish to be loved.
tavaho cat loΣox, thou wishest to be loved.
tivaho quitihon, I wish to teach.
tavaho catihon, thou wishest to teach, etc.

Of the Gerund with the Accusative, and the First Supine.

To form a sentence containing a gerund with accusative, they make use, for the present and future tenses of the verb *tibe*, and for the preterit of *xbe*, both from *be*, to go.

They also use for present and future the verb *tul*, preterit *xul*, to come.

Both are used in the third person, and are not conjugated, but are followed by *nu*, *a*, *ru*, or, *v*, *au*, *r*, of the subject, the latter when the active verb begins with a vowel, and this active agrees in number and person with the subject. Examples: *tibe nu loƷoh Dios*, I am going to love God; *tul nu rapah ala*, I come from (I have just been) whipping this boy.

¶. Note, that if either of these verbs signifying movement, which are used in forming gerunds, *tibe*, *xbe*, *tul*, *xul*, is followed by a neuter, passive or absolute verb, then the verb of movement is conjugated with the proper particles of a neuter verb, and agrees with them in number and person, and the neuter, passive or absolute verb follows without variation. Examples,

qui be var, I am going to sleep.	*koh be var*, we are going to sleep.
cat be var, thou art going to sleep.	*quix be var*, you are going to sleep.
ti be var, he is going to sleep.	*que be var*, they are going to sleep.

quin ul tihox, I am going to be taught.
catul tihox, thou art "
tul tihox, he is "
kohul tihox, we are "
quixul tihox, you are "
que ul tihox, they are "

quibe va, I am going to eat.	*kohbe va*, we are going to eat.
catbe va, thou art "	*quixbe va*, you "
tibe va, he is "	*quebe va*, they "

xinul xuque, I come from kneeling down.
xatul xuque, thou comest "
xul xuque, he comes from "

xohul xuque, we come kneeling down.
xixul xuque, you "
xeul xuque, they "

Example: *Quibe tihon chuitak amaΣ*, I am going to teach in all the villages.

¶. Note that if a sentence with a gerund contains one of these accusatives, *quin*, *cat*, *ti*, the accusative is placed first, then the verb *be*, or *ul*, without a particle; next, the pronoun *nu*, *a*, *ru*, for the subject; and last the active verb, without a particle; as:

Quixbe nu loΣoh, I am going to love you.

Kohul iq,eta, you are coming to see us.

If with this accusative form it is desired to express a wish, as, I wish to go to see you, in this case the verb *tirah*, to wish, is inserted between the accusative and the verb of movement, as,

Quix rah be nuq,eta, I wish to go to see you.

Koh rah ul y camiçah, you wish to come to kill us.

¶. Note that when in a sentence like the above we place the subject first, or use the pronouns *nak*, who, or, *ha*, he, then the arrangement is, first the subject, next the verb *be* or *ul*, and lastly the absolute verb, not the active, and the pronouns *nu*, *a*, *ru*, are omitted; as,

Ahq,hamix xibe qamo chi vochoch, the Alguacil was going to my house to take me.

Nak xat rapan? Who whipped thee? *Ha xin rapan*, That one whipped me.

In such sentences the absolute formof the verb isu sed.

¶. Observe further that when we speak in the imperative, using a gerundive sentence, as, Go call the fiscal, or, Go and bring bread; such sentences are not formed with the verb *tibe*, but with the verb *hat*, go thou, or, *hi*, go you, a syncopated form from the same verb, the *x* being dropped; this is followed by one of the pronouns, *nu*, *a*, *ru*, for the subject and then the active verb; as,

Ha taka fiscal, Go thou and call the fiscal.

Hi qamar vai, Go you and bring bread.

Ha veleçah manteles, Go thou and take the mantles.

Chapter IV. On the Formation of Participles and Verbal Nouns.

There are participles and verbal nouns derived from active, passive, neuter and absolute verbs.

Verbal Nouns from Active and Absolute Verbs.

Verbals with the prefix ah. These verbal nouns are formed from active verbs by prefixing *ah* to the root; as *loΣoh*, to love, *loΣ*, a thing loved, *ahloΣ*, he who loves, or, in whom love is; *tih*, teaching, *ahtih*, the teacher. These are declined by means of the primitive pronouns, as,

yn ahtih, I am a teacher.	*oh ahtih*, we are teachers.
at ahtih, thou art a teacher.	*yx ahtih*, you are teachers.
ha ahtih, he is a teacher.	*he ahtih*, they are teachers.

yn ahloΣoh, I am a lover, or have love. (*sic.*)
at ahloΣoh, thou art "
ha ahloΣoh, he is "
oh ahloΣoh, we are lovers, "
yx ahloΣoh, you "
he ahloΣoh, they "

These do not govern any case after them.

This particle *ah*, prefixed to nouns signifies, native country, nation or business; as **q***hamiy*, the staff of office; *ah***q***hamiy*, the person who carries it, the Alguacil; *ahpanΣan*, a resident of Guatemala.

Verbals ending in y. LoΣoy, he who loves. This termination corresponds to the *-tor* or *-trix* of the Latin, *amator*, *amatrix.* It is suffixed to active verbs of more than one syllable, and if they terminate in *h*, this letter is dropped. A primitive pronoun is prefixed, and the verbal governs the genitive, which is placed after it, as,

yn loΣoy avichin, I am a lover of thee.
at loΣoy vichin, thou art a lover of me.
ha loΣoy kichin, he is a lover of us.
oh loΣoy quichin, we are lovers of them.
he loΣoy yvichin, they are lovers of you.

Verbals ending in yom. *LoΣoyom*, he who loves; this participial is formed from an active verb of more than one syllable, the terminal *h* being dropped, and *yom* substituted, as, *loΣoh*, to love, *loΣoyom*, he who loves; *chahih*, to guard, *chahiyom*, he who guards; *etamah*, to know, *etamayom*, he who knows. *Dios etamayom ronohel ka banoh*, God knows (is the one who knows) all our works. In rare cases these verbals govern cases after them.

These participials can also be formed from absolute verbs derived from actives of but one syllable, as *q,et*, to see, *q,etoyom*, he who sees. The following sentence contains examples: *Mani q,etoyom, mani aqaxayom, ri tuya Dios chiquichin eloΣoy richin*, literally, They are not seen, they are not heard, those things which God has to give to those (who are) lovers of him.

Verbals ending in el. *LoΣonel*, he who loves. This participial is formed from absolute verbs of more than one syllable by adding *el*, as, active, *loΣoh*, absolute, *loΣon*, *loΣonel*, he who loves; active, *rapah*, absolute, *rapan*, *rapanel*, he who whips. It is preceded by the primitive pronouns, and does not govern cases after it.

In some cases, but not in all, this participial may be formed from an absolute verb derived from an active of only one syllable; in which case the termination added is *nel;* as, *colo*, to set free, *colonel*, he who sets free; *tionel camiçanels qaxtok*, a biter and a slayer is the Devil. These do not govern cases.

Verbals ending in inak. *LoΣoninak*, he who loved. This participial is formed from absolute verbs of more than one syllable by adding *inak*, as, *loΣon*, *loΣoninak*. From these participials is formed the pluperfect tense, as has already been stated. They are used like the last mentioned and do not govern cases, as, *yn loΣoninak*, I am he who loved.

Verbals ending in ic. This participial is formed from the absolute verb by adding *ic*, as, *loΣon*, *loΣonic*. It signifies the result of the action of the verb from which it is derived, as *loΣonic*, a work of love. They are not much used.

Verbals ending in em. This participial is in common use.

It is formed from absolute verbs by adding *em;* as, *loΣon*, *loΣonem*, that is a work of love. It is not united to pronouns, but is used absolutely, as *tan tiban loΣonem*, even now a work of love is performing; *tan tiban rapanem*, even now a work of whipping is performing; *tan tiban Σihalonem*, now a work of praying is performing, or, they are at prayer.

Verbals ending in bal. This is a verbal form in very frequent use; *loΣobal*, the love with which I love. It is formed from an active verb of one syllable by adding *bal*, as, *ban*, to do, *banbal*, that with which anything is done; and from those of more than one syllable by changing the terminal *h*, if there is one, into *bal*. It is conjugated by prefixing the pronouns *nu*, *a*, *ru*, and governs the genitive after it; as, *nu loΣobal avichin*, my love, or manifestation of love for thee; so, when an Indian brings a present, he says: *Nu loΣobal avichin vae*, This is the manifestation, or proof, of my love for thee.

Verbals ending in ol or ul. These are formed from active verbs of one syllable, as, *ban*, to do, *banol*, he who does; **q**,*et*, to see, **q**,*etol*, he who sees; if the vowel in the verb is *u*, the termination is *ul*, as, *cup*, to snatch, *cupul*, one who snatches. They are used with the primitive pronouns prefixed, and followed by the genitive, as, *yn* **q**,*etol avichin*, I am one who sees thee, that is, I come to see thee.

Verbals ending in oh or uh. These are formed from active verbs of one syllable. They signify the result of the action of the verb, as, *ban*, to do, *banoh*, that which is done, the work; *hox*, to fornicate; *hoxoh*, the deed of fornication; *loΣ*, to buy, *loΣoh*, the work of buying. They are used with the pronouns *nu*, *a*, *ru*, as, *nu banoh*, my work.

Verbal Nouns from Passive Verbs.

Verbals in el. These correspond to those in Latin in *dus;* they are formed from passive verbs by adding *el*, as, *loΣox*, to be loved, *loΣoxel*, that which is to be loved, Latin, *amandus, da, dum; ban*, to be done, *banel*, that which is to be done. They are conjugated by prefixing the primitive pronouns, and require the ablative after them, as, *ha banel vumal ri*, it is to

be done by me; *Dios loΣoxel vumal,* God is to be loved by me; *at loΣoxel rumal Dios,* thou art to be loved by God.

Verbals in inak. This is a past participle formed by adding *inak* to the passive verb, as, *loΣox,* to be loved, *loΣoxinak,* the having been loved. It is conjugated by prefixing the primitive pronoun and requires the ablative after it, as, *yn loΣoxinak avumal,* I have been loved by thee; *at rapaxinak rumal ahtih,* thou hast been whipped by the teacher.

Verbals in yc. These are formed by adding *yc* to the passive, and signify the passive action of the verb, as, *loΣox,* to be loved, *loΣoxyc,* the condition of being loved. They require the possessive pronouns to be prefixed, as, *nu loΣoxyc rumal Dios,* the love with which I am loved by God; *a loΣoxyc vumal,* the love with which thou art loved by me.

Verbals in om. These correspond to the Latin *tus, ta, tum,* and are formed from passive verbs of more than one syllable by changing the final *x* into *m,* and when the verb is of one syllable by adding *om,* or, if the vowel in the root is *u* or *a,* by adding *um* or *am;* as *loΣox, loΣom,* that which is loved; *banom,* that which is done; *chup,* to be quiet, *chupum,* that which is quieted. They are conjugated with the derivative pronouns, as *nu banom,* the thing that has been done by me; *nu q,etom,* that which has been seen by me; *nu loΣom,* that which has been loved (or bought) by me; *maihax,* to be held in reverence, *nu maiham,* that which is held in reverence by me. This participial is in very common use.

Verbal Nouns from Neuter Verbs.

The participials and verbal nouns formed from neuter verbs may be understood from the following examples:

Verbals in el. *Oc,* to enter, *oquel,* he who has to enter, as, *vae nu qahol oquel pa escuela,* this is my son who has to enter into the school.

Verbals in inak. *Oquinak,* the thing which has entered. These are conjugated with the primitive pronouns, as, *yn oquinak pa hay,* I am he who has entered into the house; *oquinak pe ha* that one has entered.

Verbals in ic. *Oquic*, the entrance. These are conjugated with the derivative pronouns, as, *voquic*, my entrance, *avaquic*, thy entrance.

Verbals in bal. *Oquibal*, the entrance; this word conveys all the meanings which I gave to the passive verbals in *bal.* These are used with the derivative pronouns, as, *mani voquibal aviqin*, I have no entrance with you, or, I have nothing to do with you; *mani roquibal nu vay;* I have nothing for its entrance (to enter with) my bread, that is, I have no meat to eat with it.

Verbals in em. *Oquem*, the entrance, signifies the action of the verb. It does not admit any pronoun before it, as, *xban oquem pa hay*, an entrance was effected into the house. To denote whose action it was, the genitive is used, and then the signification becomes of the present time, as *Oquem richin kahaual Jesu Christo pa templo tan qoh chi la Jerusalem*—Our Lord Jesus Christ, entering into the temple which is in Jerusalem.

Of certain Pronouns.

In sentences like some of the above, and like, "I love thee," "Thou lovest me," etc., there are five accusatives which serve for the presents and futures. They are:

quin, me.	*koh*, us.
cat, thee.	*quix*, you.
	que, them.*

The following are for past time:

xin, me.	*xoh*, us.
xat, thee.	*xix*, you.
	xe, them.

To form a sentence, we must first place the appropriate accusative as above, next, the derivative pronoun, *nu*, *a ru*, or, if the verb begins with a vowel, *v*, *au*, *r*, and then the active verb without a particle; as, *cat nu loΣoh*, thee I love; *qui nu loΣoh*, myself I love; *quix ka loΣoh*, you we love.

It will be noted that the *n* of the first person of the present accusative is dropped when the subject of the verb is of the

* In the future these are preceded by the future sign, *x*.

third person singular or plural, as *qui ruloΣoh Padre*, the father loves me; *qui loΣoh vtzilah vinak*, good men love me.

Observe that in these sentences the subject of the verb is placed at the end; and if we place it at the beginning of the sentence, as in using *nak*, who, or, *ha*, that one, then we must use the absolute and not the active form of the verb; as *nak xat bano?* Who made thee? *Dios xi bano*, God made me. *Nak xat vinakiriçan?* Who created thee? *Dios xi vinakiriçan*, God created me. *Pedro xoh camiçan*, Pedro killed us.

There are some reciprocal pronouns, which, although they have already been spoken of, must be mentioned here. They are:

vi, myself.	*ki*, ourselves.
avi, thyself.	*yvi*, yourselves.
ri, himself.	*qui*, themselves.

They are placed after active and absolute verbs, as follows:

tin loΣoh vi, I love myself.
tu loΣoh avi, thou lovest thyself.
ti loΣoh ri, he loves himself, etc.

The same meaning may be expressed thus:

qui loΣon vi, I love myself.
cat loΣon avi, thou lovest thyself.
ti loΣon ri, he loves himself.

These accusatives may also be used with verbal nouns, as:

oh loΣon ki, we love one another.

And with passive participials in *on*, as,

nu loΣon vi, I love myself.
cat loΣon avi, thou lovest thyself.
ru camiçan ri, he is killing himself.

The particle *rijl*, placed at the end of verbals ending in *b*, conveys the idea of universality, as, *loΣobalrijl*, the love which one has for all; *mahabalrijl*, the reverence which one has for all.

This explanation of what are called the "Transitions" is not very full, but contains the essentials. The other grammarians note some elliptic

forms. Thus with the negative adverbs *ba* and *ma*, there is a synthesis of pronoun and adverb, as:

> *bina* (*ba* + *quin* + *a*) *camiçah*, thou dost not kill me.
> *bat* (*ba* + *cat*) *nu camiçah*, I do not kill thee.
> *bohi* (*ba* + *koh* + *i*) *camiçah*, you do not kill us.
> *be* (*ba* + *que*) *a camiçah*, thou dost not kill them.

In the same way

> *mina* (*ma* + *quin* + *a*) *camiçah*, thou dost not kill me.

Chapter V. Of the Composition and Derivation of Verbs.

Verbs may be formed from almost all nouns, both substantive and adjective, by adding one of the following particles: *ar*, *er*, *ir*, *or*, *ur*, according to the usage of the Indians, as *mama*, an old man, *ti mamar*, to grow old; *utz*, a good thing, *tutzir*, to make oneself good; *teu*, something cold, *titeur*, to grow cold.

Active verbs may be formed from nearly all neuter verbs by adding the particle *içah* or *eçah*; as *tutzir*, to become good, *tutziriçah*, to make another good; *titeur*, to grow cold, *titeuriçah*, to make something cold.

The particle *beh* added to active verbs of one syllable, and to those of more than one syllable, dropping the terminal *h*, if they have one, forms an instrumental verb; as, *ban*, to do, *tibanbeh*, to do something with an instrument; *ti loꜩbeh*, to show love with some act, as by giving a gift. *Tipe halal ya tin chahbeh nuꜩa*, Bring a little water that I may wash my hands with it. *Ta ya hun tomin, tin loꜩbeh nu vay*, Give me a tomin that I may buy my bread. A passive may be formed from this by changing the final *h* into *x*; as, *Vae hun abah ti camiçabex ꜩ,i*, Here is a stone, with which the dog may be killed. These instrumental verbs, whether active or passive, may govern genitives after them; as, *Vae hun colo tarimbeh avikam*, Here is a cord for tying thy load; or, *Vae hun colo tixinbeh avikam*, Here is a cord with which thy load may be tied.

Neuter verbs may be treated in the same manner, though less frequently than actives, except that with them the form *ibeh* is employed. Actives and passives of these instrumental neuters are also used, as, neuter, *oc*, to enter, instrumental *oquibeh*, pas-

sive form, *oquibex*. Thus, *Xoquibeh Pedro avochoch*, Pedro entered thy house; *Xoquibex rumal Justicia avochoch*, Thy house was entered by the police.

Active verbs are formed from substantive nouns by adding one of these particles, *ah*, *eh*, *ih*, *oh*, *uh*; as *achbiil*, a companion, *tivachbilah*, to take one as a companion; *tzeb*, laughter, *tintzebeh*, to laugh at one.

Of Neuter Verbs, ending in e, of more than one Syllable.

There are in this language some neuter verbs, of more than one syllable, ending in *e*, as, *pae*, to stand up, q*u*q*ue*, to sit down, q*ule*, to marry, *hote*, to ascend. All these form active verbs by dropping the *e*, adding the initial vowel of the root, and suffixing the particle *ba*; thus, *pae* forms *paaba* to erect; q*u*q*ue* forms q*u*q*uba*, to set down; q*ule*, q*uluba*, to give in marriage; *hote*, *hotoba*, to lift up. *Qui pae*, I stand up, *tin paaba*, I erect something; *qui* q*u*q*ue*, I sit down, *tin* q*u*q*uba*, I set something down.

From these verbs ending in *e* certain participials are formed of frequent use, by changing the *e* into *l*; as *xuque* to kneel down, *xuqul*, he who is on his knees; *pae*, to stand up, *paal*, he who is on foot. The plural of these participials is formed by changing the final *l* into the initial consonant of the root and adding *oh* or *uh*; as *paal*, he who is on foot, *paapoh*, those who are on foot; *çaal*, clothing or anything else laid out to sun, *caacoh*, all the things laid out to sun. An exception is q*ulan*, married or united, plural q*ulu*q*uh*.

From this participial in *l*, are formed some active verbs with instrumental signification by adding *ibeh*. As this is a difficult point, it is best shown by examples. *Qui* q*otze*, to lie down; its participial is q*otzol*, he who is lying down; *tin* q*otzolibeh*, I lie down upon something. *Tipe hun varabal* q*ul*, *ru*q*in hun pop*, *tin* q*otzolibeh*, Bring me a sleeping dress, and a mat, so that I may lie down upon it. So, *qui* q*uke*, I sit down, *ti* q*ukulibeh*, I sit down upon something; *Dios nima ahauh*, *ru* q*ukulibeh xi tan* q*,hacat puakin*, God, the great Lord, is seated upon a seat of gold, or emeralds.

Of Frequentative Verbs.

These include frequentative verbs properly, and also distributive verbs.

Active verbs of more than one syllable, ending in *h*, change the *h* into *la*, as, *tin çipah*, I divide, *tin çiala*, I divide many times, or among many persons. Active verbs of only one syllable add the vowel of the root, and then the particle *la*, as, *tin chap*, I seize, *tin chapata*, I seize often or many things. There are not many frequentatives proper, with an active sense, in this language.

With regard to the passive verbs derived from these frequentatives, they are not formed as the other passives and absolutes above mentioned, but as follows: the *a* in which the frequentatives end is changed into *o*, and then the absolute is formed in *on*, and the passive in *ax;* as, *tin çipala*, I divide often, *qui çipalon*, I divide out, *qui çipalox*, I am divided out frequently.

Chapter VI. Of some Particles and Adverbs.

The particle *vi* is much used in this language, and for many purposes.

Whenever time or place is specified before the verb, the latter must be followed immediately by *vi;* as *chi rochoch Dios qo vi Padre*, In the house of God is the father. But if the verb is placed first, the *vi* is not used; as, *qoh chi rochoch Dios*, he is in the house of God (the church).

Again, in employing the dative, if it precedes the verb, the latter must be followed by *vi;* as, *chi richin Pedro taya vi*, to Pedro thou must give. But if the dative is placed after the verb, the *vi* is not used; as, *xnu ya chirichin Pedro*, I gave it to Pedro.

It has also the signification of the instrument, if it immediately follows the verb; as, *abah xin camiçah vi tziquin*, with a stone I killed the bird; but if the instrument is placed after the verb, *vi* is not used, but the particle *chi*, as, *xin camiçah tziquin chi abah*, I killed the bird with a stone.

Whenever the verb is preceded by the particle *ha*, the particle *vi* must follow; as, *Ha quix colotah vi*, With this you will ascend to heaven.

In other cases *vi* is used to convey affirmation, as, *Kitzih chi xaban vi mac*, Certainly you committed a sin.

The particle *ach* has no signification by itself; but joined to nouns it conveys the idea of participation in their signification, and it is used with the possessive pronouns; as, *ahmac*, sinner, *achahmac*, he who sins jointly with another; *vachahmac*, my accomplice in sin; *achbilatz*, he who goes with another; *vachbiil*, my traveling companion.

The particle *quereqa* is illative, and corresponds to *ergo* or *igitur*, therefore, then, for that reason. Whenever it precedes a verb in this sense, the latter must be followed by the particle *vi*; as *Quereqa ta loꜫoh vi Dios*, Therefore love thou God.

¶. There are four very important verbs which are placed absolutely at the end of sentences containing a gerund with accusative. They are *el*, departing, *apon*, arriving, *kah*, descending, *pe*, coming; and this particle *ꜫaneh*, or *aꜫaneh*, which means "upward."

The verb *el* is used by the Indians thus: *ta qama el ri plato*, Take out, departing, this plate; *ta tixa el ya qoh chupam xarro*, Pour forth, going out, the water which is in the pitcher. The Zutuhils are accustomed to add *o* when the sentence ends in *el*.

The verb *apon* means "arriving there," not "coming here." It is used as follows: *ta biih apon chire fiscal chuac quin apon chire*, say to the fiscal on arriving there (or, when thou arrive there) that to-morrow I am going there. *Chuak tel apon camahel ruqin Padre*, To-morrow will go forth my messenger to the place where the Father is.

The verb *kah*, is used when one being in an elevated location speaks, or writes, or sends to one who is situated lower. Thus when one is in Atitlan and speaks of the coast, he would use this *kah*, as, *tibe qamar kah q.ih taꜫah*, they are going to carry flowers, descending (or down) to the coast.

The verb *pe*, to come, is used as follows: *ta tzih pe cande*

light, coming, a candle (come and light a candle). Thus the preacher says to the people, that they be attentive during the sermon: *Ti ya pe yqux, ti ya pe yxiquin, tivaqaxah pe, vae to ꜫolah tzih xtin biih chivichin*, Give your hearts hither (coming hither), give your ears hither (where I am), listen (in this direction), they are precious words which I shall speak to you.

The particle *aꜫanch*, means upward, Latin, *sursum*, as, *qui muluu aꜫanch*, I look upward.

The particle *can* means "remaining;" as, *xu biih can kahaual Jesu Christo*, the aforesaid our Lord Jesus Christ; *xi ru pixabah can nu tata tok xbe panꜫan*, my father discharged me, I remaining behind, he going to Guatemala: *quere nu tzih, nu pixa, vae xtin ya can xtin qoh ba can*, These are my words, my commands, which I give to remain, as I shall go away. The expression *xambey can*, means, remain behind, *chuih can*, in my absence, after I had left.

The particle *na* has no signification when used alone; but when joined to other words it has various meanings. It is from *nabey*, first, or, the first. Thus it may mean "until," Latin, *donec*, as, *cat nu chabuçah na chicam tiqo na nuqux chavih qate ti tuker nuqux*, I shall punish thee and shall not be satisfied until I have visited on thee my anger. *Tul na Padre qateqa cathe*, Do not go until the father hears thee; *qahaok na Padre tibiin ru chohmil chuo qateqa tinu kiquih*, I shall not consider it true until the father tells me. *Nu qux na tahoon tinu ya chaue*, Until my heart desires it, I shall not give it thee. *Tin biih na ruchohmil Justicia*, In the first place I shall tell the truth to the magistrate; *qacamic na*, until death, *qe ta na*, presently, after a while. A boy about to be whipped will say, *humul chita na*, pardon me this time, wait until the next time.

The particle *bala* means "somewhere." *Ba qo vi Padre?* Where is the father? *Bala qo vi*, Somewhere, I don't know where. It also corresponds to all four of the adverbs of place, *ubi, unde, quo, qua*. *Ba xpe vi Padre?* Whence came the father? *Bala xpe vi*, I don't know whence he came. *Bi che el*, or, *nak che el?* How? In what manner?

Bilanak, "something," "anything." *Tok bilanak ti biin*

chaue ytzel tzih, ma qutuba, When any one speaks evil wor[ds] to you, do not answer him. *Mani bilinak xu biih Padre ch[...]*, The father did not say anything to me.

Other particles: *qabala*, from time to time; it may be us[ed] with repetition; *qahantak la nu nantil*, the same, *qa ru naht*, th[e] same; *qo quipe, qo qa mani*, sometimes I go, sometimes no[t]; *mani humul vakan chirochoch*, not one time have I put foot [in] his house; *vave*, here; *varal chire*, there or then, *chila*, ov[er] there, far; *halal*, a little; *halal chic tiraho tiyh*; the food lacks [a] little, it is not ready, an Indian phrase; *halan-halqat*, diffe[r]ently, pl., *halahoh qui qohlem ahaua*, the modes of life of th[e] chiefs are different; *halahoh que tzihon*, they speak differentl[y], some well, some ill; *xere*, only this; *huqiçic xa xere tin bi[i]ri*, only this do I say to thee; *huqiçic** *xtin ya chavichin re*, [...] *vae*, this only will I give to thee; *hiquil*, intimates a fixed pu[r]pose, as, *hiquil nube ic chuak*, My departure to-morrow is ce[r]tain; *kitzih*, truly, certainly; *chi kitzih vi chi*, the same, *kitzih utz Dios*, truly God is good. The following are use[d] with reference to past or future time in narration or reference, *haok, katok, tok;* but in asking about past time they sa[y] *xhaniqal?* How much time? And for future they say, *ha[ruh]*, when? *Haruh cat be?* When wilt thou go?

* The word *huqiçic* is a compound of the numeral one, *hun*, and the verbal *qiçic*, from *qiz*, to finish, to end, hence, "that which ends in one" or is alone. (*Coto*)

SUPPLEMENT.

The following additional material, necessary to a grammatical survey of the tongue, I have culled from the various MS. sources heretofore mentioned.

Comparison of Adjectives.

This is accomplished by the use of the particles *chic*, as, *nim chic halal*, a little larger, *ki*, and *atza*, as, *atza quixan pe*, come a little nearer; and by adding the past participles, *ꝗovinak* and *yalaquhinak*, which mean to pass beyond, to exceed, as, *ꝗovinak chi nim*, greater (it exceeds in greatness), *yalaquhinak chi utz*, better (it surpasses in goodness).

Interjections.

Ahkook! or *akookee!* Ah! Alas! Oh! Expressive of sadness or compassion. This is much used by the priests in their sermons.

Acay! When one is beaten or ill treated.

Aꝗe! When one is suffering pain, as, for example, when bitten by some animal. The correlative of this interjection in the particle *Σe*, which is placed at the end of the sentence, as, *Aꝗe, xqui cam Σe!* Alas! I shall die!

O, A, Ae, are exclamations of admiration as in the compounds, *A bin ꝗa, O maihan re*, etc.

Aco! Oh! expressing a wish, as, *Aco mixat nuꝗul*, Oh! that thou hadst come!

Kitah, kitari, kitanari, kitanaꝗa, kitanaan, queretah, queretare; all these are desiderative or deprecatory. The root of the first five is the particle *ki* which is used to ask a question in a confident and friendly manner, hence *kitzih*, the truth.

Adverbs.

Affirmative Adverbs. *Kitzih*, truly; *kitzihan*, very truly; *xaiꝗa*, also; *ꝗo, he, xaviutz*, it is well; *haquere*, be it so; *haꝗaquere*, in the same way.

Negative Adverbs. *Mani* or *maqui*, not; *xax mani vi*, by no means, not at all; *mahani*, not even; *maquiam queretah*, it is not so; *mahaniok*, is a negative indicating past time, as, *mahaniok tikaΣih tok mi xinol*, the sun had not yet set when I came. The particles *ba* and *ma* are used as negatives in the singular number, second and third persons, especially with imperatives, as, *ba ban ri*, do not thou do that; *ba malih aꝗux*, do not be faint-hearted. In the plural these words become *bi* and *mi*, as, *mi ban ri*, do not you do that; *bi pokonariçah ivii*, do not abuse one another. The form *maqui tanaan*, a compound of *maqui*, not, *tan*, particle of present time, and *an*, an emphatic particle, is a negative, corresponding to the affirmative *ki tanaan;* they have the meanings, "not now at any rate," and, "even now at any rate." The compound *mamanion*, is a negative interrogative, or alternative, as, *avetaam pe, mamanion?* Dost thou know

me, or not? *Avetaam pe nu qohlem, mamanion?* Dost thou know me, or not? *Quere pe, mamanion?* Is this so, or not?

Interrogative Adverbs. The general interrogative is *nak?* What, or, What is this? Who? Which? *Nak qui xox vi?* Who art thou? *Nak la qa rumal?* For what reason? *Nak pe ri?* What is this? *Ba*, where! *Ba pe qo vi?* Where is he? *Balaqa qo vi ruchohmil?* Where is the truth of this? *Bi* and *be* also have interrogative force, as, *Be chok ia vetamah vi ri?* How didst thou know it? *Been xa ban?* How didst thou do it? *La kitzih*, truly? as, *La kitzih pe xabiih ri?* Truly, didst thou say this? The particle *maki* is in very common use for the affirmative interrogatives, well, well then, etc., as, *Maki tekumu halal ya?* Then, thou willst not drink water?

Dubitative Adverbs. The particle *la* expresses a doubt as to whether the action referred to has occrured; as in answer to the question, Has the father come? The reply, *Mi la xul*, or *Mi xul la*, means, He may have come, it is possible. A much used compound of similar signification is *pachΣom qa vach*, from *pachΣom*, to turn, to change; it is used with the possessive pronouns, as, *pachΣom ru vach nuqux*, I am in doubt, literally, my mind (*heart*) changes its face.

Numerals.

1—*hun*.
2—*cay*.
3—*oxi*.
4—*cahi*.
5—*voo*.
6—*vakaki*.
7—*vuku*.
8—*vakxaki*.
9—*belehe*.
10—*lahuh*.
11—*hulahuh*.
12—*cablahuh*.
13—*oxlahuh*.
14—*cahlahuh*.
15—*voolahuh*.
16—*vaklahuh*.
17—*vuklahuh*.
18—*vakxak lahuh*.
19—*beleh lahuh*.
20—*hu vinak*.
21—*hu vinak hun*, &c.
40—*ca vinak*.
41—*hunroxqal*.
42—*cay roxqal*, &c.
60—*oxqal*.
61—*hun ru humuqh*, &c.
80—*humuqh*.
100—*oqal*.
101—*hun ru vakqal*.
120—*vakqal*.
121—*hun ru vukqal*.
140—*vukqal*.
160—*vakxak qal*.
180—*belehqal*.
200—*otuc*.
300—*volahuhqal*.
400—*omuqh*.
500—*omuqh oqal*.
600—*omuqh otuc*.
700—*omuqh volahuh qal*.
800—*caΣo*.
900—*oxqal roxoΣo*.
1000—*otuc roxoΣo*.
8000—*hu chuvy*.

The numeral *voo*, five, when joined with the possessive pronoun loses its initial letter, as, *roo*, his five. Verbals are formed from these numbers, as from other radicals.

The ordinal numbers are formed from the cardinal by prefixing the possessive pronoun and dropping the final letter.

rvhu, first.	*roo*, fifth.
ruca, second.	*ruvakak*, sixth.
rox, third.	*ruvuk*, seventh.
rucah, fourth.	*ruvakxak*, eighth, etc.

The use of *numeral particles* is very frequent. I take the following list from Torresano's Grammar in the order he gives them.

pah, for counting words. With this particle the numerals lose their last vowel, and *vakaki* its last three letters, as, *hupah, capah, oxpah, vakpah*, &c.

rabah, for counting skeins, threads, or things sewed ; *hurabah, carabah*, etc.

Σa, for counting hands, and fives, *huΣa, caΣa, oxΣa*, etc.

q*ulah*, for counting pairs.

moΣ, for counting handfuls, or fists.

lep, for the same.

q'*uh*, for counting drops.

biΣ, for counting chips and crumbs.

lic, for counting spoonfuls.

yacah, for counting large things, as beams, logs, and weights.

remah, for counting provinces.

q*hob*, for counting districts.

q*olah*, for counting spherical things, such as eggs, balls, etc.

cholah or *ley*, for counting things arranged in order.

tzeah, or *chiah*, or *quiah*, for counting bundles of things tied together.

chacah, for counting bundles like those of sarsaparilla, tied together.

vi, for counting shoots and stems of trees, etc.

telah, for counting armfuls of wood or grass.

ram, for counting clubs or sticks.

molah, for enumerating the differences between things.

taz, for counting high things, as the ceilings of rooms, or the upper rooms of a house.

rap, for counting strokes or blows.

perah, for counting paper, the leaves of a book, tortillas, or other thin articles which are laid one over the other.

buçah, for counting things that are doubled or folded, as pieces of cloth.

q'*iz*, for counting sewed sheets or other sewed articles.

hah, for counting armfuls of woods, sticks, etc.

yatah, for counting bundles or other tied articles.

Σeteh or *borah*, for counting small bundles of grass or wood which can be carried under the arm.

cep, for counting sites of villages.

bolah or *Σer*, for counting bundles of straw.

çutah, for counting pieces of sown land.

tzobah, for counting small patches of corn-land, of good soil.

q*utu*, for counting spans.
*xa*Σ, for counting paces.
le, for counting spaces between floors.
tunah, for counting degrees, chapters, sins, law-suits, etc.
Σ*ala*, for counting cacao grains, by scores.
vinak, for counting months according to the method of the Indians, from 20 to 20.
a, for counting years.
may, for counting years by twenties.
mul, for counting repetitions.
oc, for counting with exclusion, *hunoc*, one only, *cayoc*, two only, etc.
Σ*at*, for counting long strips.
hal, for counting changes.
q*hay*, for counting businesses.

To these from Torresano may be added from other sources:
bic, for counting songs, words, or blows, as *hubic chibix*, one song.
lah, for counting 14 at a time.
patal, for counting loads, *hun patal a*q*am*, one load of salt, etc.

To express that a quantity is finite and can be counted, the word *choyol* is used; to express that it is infinite or cannot be counted, they have the word *ramal*; or the negatives *maqui choyol*, *maqui* Σ*atal*, innumerable.

To express a half, the word *tanal* is placed before the numeral, which takes the possessive, as *tanal ru cay*, *tanal rox*, *tanal ru cah*, etc.

Particles.

In American tongues the study of the particles is preëminently required in order to gain an insight into the shades of meaning between similar expressions. To them also we must turn if we would trace these tongues to their primitive forms, and gain a clear conception of their organic peculiarities. By some writers these particles are considered worn down verbal or nominal roots, but I rather hold that this is the exception, and that most of them are true radical forms themselves, and must be ranged under a grammatical category foreign to any known to the Latin grammarians.

This question need not be discussed here, and it will be enough for practical purposes to arrange in alphabetical order the principal but by no means all the particles found in the Cakchiquel.

Aco. Expresses satisfaction, as if one had found that which he was searching for.

*A*Σ [illegible]. Verbal particle, see p. 404.

Ar. Particle to say that it is well. *Utzan*, it is well.

A[illegible], or *A*[illegible]. Generic part. applied to any animal, bird, or bee such as builds itself a house.

A[illegible]. Enough; [illegible] q[illegible], [illegible]q[illegible] *ape*, "trae bastante."

B[illegible]. Imperative and prohibitive particle.

B[illegible]. Many times; [illegible] *bijm chaue*, I have often told you [illegible]

Beh. Particle added to verbs to signify the instrument with which the action is accomplished.

Ben. Particle to express "since" or from a certain time; *xruliben Padre*, since the Father came; *xu ka hi bem (sic) ya panuvi manitan qui qule*, since I was baptized, I have not sinned.

Can. Particle signifying past time; *nu biin can*, I have already said.

Cani or canih, soon; *canicabe vacami man chic catqohe vaue, ahora luego vete ya no estes aqui.*

Co. Particle to concede or grant something; *coco*, all right, very well, yes.

Cohol, between; *cohol hay*, between the houses.

Chic. See p. 376.

Ha, that one; also, it is, or, it is so; *ha ri*, it is thus; also in causal sense, *ha nim vi ri Sancto*, because the Saint is great; something great or strong, *ha Σih*, a hot sun, *ha hab*, a heavy rain.

Hak, to open out, or to separate things joined; *tahaka ru nakavach*, open your eyes; *hakal vuh*, the book is open; *ti haka yxiquin*, open your ears, *i. e.*, listen attentively.

Haz, to shut up, hence a secret, in secret; *hazha pa ru xiquin*, to tell in the ear.

Ho, interjection intimating going; *hoho*, come along, let us go hence; applied to the woman who offers herself to a man; *tu ho ri yxok*, the woman offers herself; of the day which goes quickly (as *holoho*); *xholo yan Σih*, the day is soon gone; *xholoho ranima*, his soul departed (he died); *hote*, to go upward, rise; *cat hote chirih queh*, get on your horse; *hotoba*, to lift, to raise up; *hotay*, the sprouts of trees which shoot up, also the descendants, offspring of a man; *enuhotay*, my descendants.

Yan, particle denoting brevity; *xatul yan*, you have just come; *xqo yan xinul*, I have already come. Thus this particle may mean both a short and a long time.

Yx, part. of past time.

Ychal, part. denoting plurality.

Yben, part. joined to names parts of the body to distinguish them, as *qalqaxibeni (sic), ri xa*, the water came to my knees.

Ka, part. of direction, downward; as verb, *ka*, to descend, *mix ka chi, xibalhay*, he descended into hell; to tear down a house; to set (of sun or moon); to diminish (of a boil); to descend in health, to grow sick, etc.

Ki. 1. An interrogative, putting a question in a friendly manner expecting a truthful reply. 2. In space, that which is locally nearest, as, *hakiha vochoch ri qo oc chachi bey*, my house is nearest the road.

La, particle to intimate that one has not seen what has taken place; expresses a doubt.

Ley, part. to denote that something is one of a class, *hu ley vinak*, a person of one, age, nation, dress, color, etc.

Na, first, in all senses. Hence, as a verbal, to be first, to await others;

nare, before me, thee; etc; *naek*, but, although (*i. e.*, = consider first); *navipe*, or *naype*, then, next, and.

Naht, far, deep; of time, long.

Noc, a word of disfavor, or disapproval; used, for instance, when one counts erroneously, or makes a mistake.

Paki, at once, immediately, *tin ban paki*, I do it at once.

Pum, or *Pu*, in, within; hence, the stomach, belly or bowels, as the "inwards" of old English writers.

Pe, toward this place, hither; as a verbal, to come hither.

Ta, a particle of courtesy used by and to married people; as, *Dios e chahin ta*, God protect you; hence, *ta ta*, O lord!

Tah, particle to express like or desire, used in asking something which one is uncertain about receiving; as a noun, pleasure, satisfaction; as a verbal, to desire, to wish.

Tahin, particle of present time, as *tan pe que tahin yxoki chuque xic a ray?* are the women now grinding my corn? Ans. *Tan que ta hi*. They are even now doing it. In the combination *qatahin*, it means "a little," a short time.

Tak, conveys the idea of repetition. With reference to events it signifies that they happen recurrently; added to numbers above five it means a division among many. Thus they say of intermittent fever, *ku tak peti rax ter churih*, I am suffering from recurrent chills. It is also used to form certain plurals which have an implied idea of recurrence, as, *ronohel ta mul*, all the time, every time.

Tan, part. of present time, see *tahin*, and page 385.

Toze, an exclamatory particle used to call a person who is near.

Va, a particle of assent, or of intimation that one is near what he is seeking.

Ve, primarily expresses a doubt, and from this a concession, hence it is used to signify consent or yielding to a request: *ve ta*, be it so.

Vi, see page 403.

Xambey, after others; as, *xambey can*, he comes after, either in space or time.

Xe, below or beneath: *xe hoy*, beneath the house; *ru xe che*, the root of a tree.

qa, conveys the idea of a short distance either in space or time, as qa *xe tzal Pedro*, Peter came a short time ago: qa *aquai* yq, the new moon; qa *aquai Pedro*, Peter is young yet; qa *tan tahin misa*, they are still saying mass; qa *aqa hoy*, a newly-built house.

On a Case of Human Congenital Malformation. By Harrison Allen, M.D.

(Read before the American Philosophical Society, December 21, 1883.)

I desire to place upon record the facts in the case of a man born with rudiments of the superior extremities. Similar cases, it is true, have been recorded, and in a sense, this history lacks the claim of a positive contribution to knowledge. But it is well to record each example of unusual conformation, when novel facts pertaining to the adult state, to habit and to acquired deformity, can be demonstrated.*

The case is one of a group denominated Perobrachia and is embraced in the following account:

John E. Casey, aged sixty-four years, one of a family of seven well-formed children of healthy parentage was examined Nov., 1883. The subject was four feet and seven inches in height. In the place of the left superior extremity a small pedunculated lobule one inch in length was suspended from the axilla a short distance behind the group of axillary hairs. This lobule retained a slender rod of bone which could easily be determined, and which doubtless was homologous with the bones of the normal left superior extremity.

The right superior extremity was a small unidigitate member, bent at the middle so as to resemble a letter L and when at rest so disposed to the trunk as to correspond in length to the side of the thorax.

The humerus was apparently dislocated upon the dorsum of the scapula on an outward extension of the glenoid cavity, and the bone was thus held in an exceptional relation to the scapula. The shaft of the humerus was bent at the distal third so as to present a convexity outward and yielded a short distance above the elbow to its lateral side, a small spine which while detected with ease, did not form an elevation of the skin.

The position of the olecranon and that of the elbow-joint could be readily determined. The remaining portion of the extremity represented elements in a single axis excepting at the terminal phalanx. Within this axis the bones of the forearm, of the metacarpus, and the two phalanges of one digit could be identified.

The bones of the left shoulder-girdle were small but complete.

Of the right elements it was found that those of the shoulder-girdle were unusually well developed. Both scapulas were elevated, and the clavicles obliquely placed, the sternal ends determining the lowest, and the eleva-

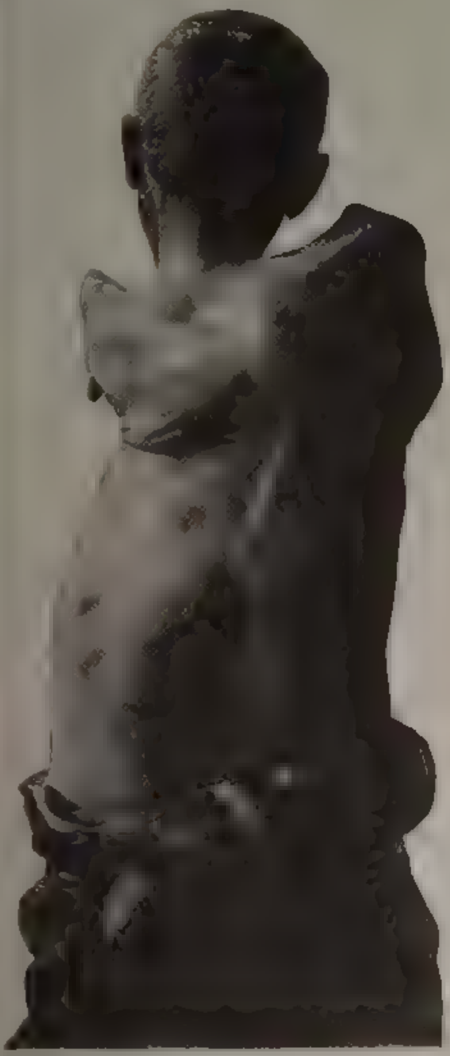
* A somewhat similar specimen to the one described is reported by Otto (Monstru. Tab. xvi, figs. 7, 8, p. 138). The condition was symmetrical, the radius absent, and the single finger was identified as the fifth, since the ulnar nerve passed to it. The subject was an unviable female fœtus, of the seventh month. Förster (Missbildungen) refers to several cases; references imperfect and not reliable. See also Anger (Nouveaux Elements de l'Anat. Chirurgicale, 573, 574).

tion of the scapulas (through the agency of the trapezii, rhomboidei and elevators of the angle of the scapula) the highest levels

Fig. 1.

Fig. 1. Front view of a case of Perobrachia, showing the rudiment of the left upper extremity, and the undigitable right upper extremity.

FIG. 2.



k view of a case of Perol rachis, showing the rudiment of the left lty, the disproportion between the scapulas, the deviation of the mn, and the relaxation of the muscles of the buttock.

The *measurements* were as follows:

Left Side.

The length of the spine of scapula	5″.3‴
Greatest length of scapula...........................	5″.6‴
Distance from angle to tip of acromion.............	6″.6‴
Length of clavicle..................................	3″.6‴

Right Side.

The length of spine of scapula..........	5″.6‴
Greatest length of scapula..........................	5″.6‴
Distance from angle to coracoid process............	6″.9‴
Length of clavicle..................................	6″.0‴
Length of humerus...................................	10″.0‴
Distance from proximal border of exostosis to the elbow....	4″.0‴
Distance from elbow-joint to wrist-joint............	2″.0‴
Length of first phalanx.............................	1″.6‴
Length of second phalanx.......	0″.9‴

The *motions* of the left extremity were confined to upward traction ‹ the scapula as already mentioned, and backward traction of the lobul the latter apparently through the agency of a pannicular muscular shee

The motions of the right extremity embraced the powerful effects of tl tractors of the scapula, and the flexors and extensors of the forearm. T shoulder-joint being anchylosed, the extrinsic muscle of the should girdle, the trapezius, the serratus magnus, the levator anguli scapulæ, a the serratus magnus, and possibly the sub-clavius, were mainly effective moving the extremity. The pectoralis major was also powerful. Abdu tion of the arm (probably rhomboidal) was associated with marked medi (*i. e.* vertebral) deviation of the scapula; adduction (pectoral) with equal marked lateral deviation. Abduction was limited, the arm not bei carried out from the trunk beyond an angle of 45°. Adduction on t other hand was powerful and complete.

The motion of the elbow permitted all the portion of the limb plac distally to the joint to be moderately extended. At the end of extensi the elbow was distinctly angulated. At the end of flexion the forea and hand are doubled up to the median side of the humerus. The term nal phalanx when the limb was at rest was strongly adducted, and a entering angle was formed between the median border of the first and t second phalanx. When the limb was flexed this angle was directed ward and outward; but when the limb was extended it was directed o ward. From this circumstance it may be said that the flexion and tension at the elbow-joint was accompanied with sub-rotation.

Together with the primal or congenital defects numerous acquired ‹ were present. The most conspicuous of these was a lateral deviatio the vertebral column to the right, the result probably, of the unanta ized traction of the muscles of the right side, and in part also to impe

ossification in the bones comprising the column. As a result of this deviation the scapula of the left side was displaced and the angle lodged *behind the upper border of the ilium* It thus appeared to be wedged down in the pelvis. A second acquired defect was found in the muscles of the buttock and the back of the thigh. The gluteus maximus of each side was feeble, and in no position of the body became tense. The entire labor of holding the trunk erect was thrown upon the hamstrings which, particularly the biceps flexor, was on each side of enormous size.

Under the head of *habits*, the result of the defects described, may be included the manner by which the subject could attend to acts of the toilet and to the handling of tools, etc Like most persons whose arms are either defective or absent the toes and lips become highly functionalized and the methods of their use are in this case no different from others recorded Cases has supported himself, honorably, as a farm laborer and peddler, and has, for a period of years extending beyond the average longevity, preserved good health and character For many years he was employed as a driver of oxen The guiding staff was held by the powerful pectoral muscles between the arm and the chest A nail can be driven with accuracy and force by placing the handle of the heavy hammer between the arm and the chest wall, holding the nail upright between the first and second toe of the left foot, and while standing erect on the foot of the opposite side, he flexes the left leg at the knee. In this position the body is supposed to be standing on the right leg, the left leg flexed and the left foot raised upon a bench or stool The motion of striking the blow is secured by throwing the trunk suddenly forward from a position of backward traction or extension, the shoulder muscle being occupied keeping the hammer in position between the arm and the trunk. The act of writing is accomplished by holding the pen between the flexed arm and the side of the head the lips being used in guiding the pen. Other acts such as dressing, shaving, etc , are possible

Remarks.—The modern method of studying congenital defects, as formulated by Meckel and St Hilaire, father and son, is based upon the assumption that every embryo exhibiting an aberrant disposition of parts is an example of perverted or arrested development The school of St Hilaire accepts the conclusions that such perversions and arrests are exhibitions of and reversions to the characteristics of lower animals *

While these statements cannot be in all respects controverted, an error is prevalent as to the systematic value of aberrant structures. An exam-

* "These (specimens) compose organic entities perfectly characteristic, amenable to law but placed in another kind of regular arrangement. When monsters are thus rigorously determined, I propose to group them after the zoological method and to determine for them genera and species (Etienne Geoffroy St. Hilaire, Ann Sc Nat xiv 1828, 408.)

** "An organ exhibiting anomaly which is essentially the same in structure as a part normally developed in a lower form, may be said to be degraded, and thus to have taken on the characters of creatures lower in the scale than itself." Isidore Geoffroy St. Hilaire, Propositions, etc , 61

ple in the form above described, of a solidungulate extremity would suggest to the evolutionist a comparison with the foot of the horse; the single unguis, the nearly straight though multi-articulate axis from the unguis to the elbow, the main lines of motion, are identical in the two instances. But it is equally like the wing of a bird, and an analogy might be instituted with that limb: the extreme degree of flexion possible between the two main segments, the presence of two bones in the forearm, are the same in both. Such a method of comparison is no more conclusive than the likeness of clouds to camels and to whales. We can say with Polonius, such things are very like, and yet be no nearer in the end to a conclusion than in the beginning. The real comparison and only comparison which is profitable to make is with the general history of the superior extremity studied as a distinct subject, no matter what special form of limb may be differentiated in various animals. The presence of the exostosis upon the humerus is in this way comparable to other spinous outgrowths such as are seen in long slender shafts (as in the ribs of fish and of birds), and in many examples of diseased and perverted action in the long bones of man.

While such strictures are applicable to the various regions of the body, they cannot be made to apply to the subdivisions of a given anatomical system. The variations in the muscular system of man, for example, are often precise instances of reversion to the normal arrangement as met with in lower forms. In this way the study of minute variations in the shape of a muscle, or in the distribution of a nerve or a blood vessel, is more valuable for the purpose of the student of evolution than is the investigation of monstrous deformations.

Stated Meeting, January 18, 1884.

Present, 17 members.

President, Mr. FRALEY, in the Chair.

The resignation of Dr. William Camac was received in a explanatory letter dated Woodvale, January 7, 1884, and, on motion, accepted.

The receipt of the Zeisberger and Perlæus MSS. was acknowledged by letter, signed Edmund de Schweinitz, dated Bethlehem, January 7, 1884.

Letters of acknowledgment were received from the Anthropological Institute of Great Britain and Ireland (110–112), and Yale College (XV, i).

Letters of envoy were received from the Geological Survey of India, U. S. Coast Survey and Smithsonian Institution.

Donations for the Library were received from the Societies at Batavia, Bonn and Freiburg; the Geological Survey of India; the Society of Antiquities, Copenhagen; Royal Society, Upsal; Meteorological Institute, Vienna; Royal Academy and Bureau of Statistics, Brussels; Geographical Societies at London, Paris and Bordeaux; Geological Societies at Dresden and London; Nature; American Journal Science; Franklin Institute; College of Pharmacy; Profs. H. C. Lewis, E. D. Cope and H. Phillips, Jr.; Wyoming Historical Society; U. S. Coast Survey; Fish Commission; National Museum and Dr. Alex. Graham Bell.

The death of Strickland Kneass, at Philadelphia, January 14, 1884 (born July 29, 1821), aged 62 years, was announced, and the President empowered to appoint a member to prepare an obituary notice of the deceased.

Dr. Thos. G. Morton was appointed by the President to prepare an obituary notice of Dr. Kirkbride.

Mr. Wm. V. McKean, for that of Gen. Kane.

Mr. H. L. Carson, for that of Gen. Humphreys.

Prof. Cope exhibited fossil specimens of genera and species of the family of the *Oreodontidæ*, and described their characteristic structure and geological relations.

Commodore E. Y. McCauley's colored drawing of a sarcophagus in Memorial Hall, Fairmount Park, Philadelphia, was exhibited by the Secretary, who described the legends on its cover, translated by Com. McCauley.

Dr. Frazer communicated a table of barometric levels taken by him recently in Texas and New Mexico, and described the geological structure of the neighborhood; also, specimens of Maguëy needle and thread; and a specimen of the cheap handmade waterproof Mexican blanket. Prof. Cope remarked that the valley formation was Tertiary.

Mr. Lesley was elected Librarian for 1884.

The Committee on Mexican MSS. was continued.

The following *new members* were elected:—

Prof. Wm. L. Stevens, of Brooklyn, New York.
Prof. Henry M. Baird, University of the City of New York.
Hon. William D. Kelley, of Philadelphia.
Col. James Worrall, of Harrisburg, Pa.
Mr. Heber S. Thompson, C.E., of Philadelphia.
Prof. John M. Maisch, M.D., of Philadelphia.
Capt. Richard Mead Bache, U. S. C. S., Philadelphia.
Prof. John Ashhurst, M.D., of Philadelphia.
Hon. George H. Boker, of Philadelphia.
Hon. James R. Ludlow, Judge Court Common Pleas, Phila.
J. Solis Cohen, M.D., of Philadelphia.
Mr. Henry Flanders, of Philadelphia.
Hon. Richard Vaux, of Philadelphia.
Prof. Ellerslie Wallace, of Philadelphia.
Prof. Isaac Sharpless, Haverford College, Pa.
Col. William Ludlow, Chief Eng., Water Dep., Philadelphia.
Prof. John Bach McMaster, University of Pennsylvania.
Lord Coleridge, Chief Justice of England.
Prof. Allen C. Thomas, Haverford College, Pa.
Rev. Jesse Y. Burk, Gloucester co., N. Y., Sec. B. I. Un. Pa.
Mr. Isaac Burk, of Philadelphia.
Prof. M. B. Snyder, Central High School, Philadelphia.

Stated Meeting, February 1, 1884.

Present, 13 members.

President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Henry M. Baird, James Worrall, Heber S. Thompson, R. Meade Bache, John Ashhurst, George H. Boker, Richard Vaux, Isaac Sharpless, Wm. Ludlow, John B. McMaster, Allen C. Thomas, Jesse Y. Burk, Isaac Burk, and M. B. Snyder.

A letter declining membership for sufficient reasons was received from Henry Flanders.

Letters of acknowledgment were received from the Tacubaya Observatory, Mexico (110, 111), and the Franklin Institute (113).

Letters of envoy were received from the Central Physical Observatory of Russia; the Ministry of the Dutch Colonies, through the Department of State, U. S., Washington, D. C., January 25.

A letter requesting full exchanges was received from the Johns Hopkins University, dated Baltimore, January 26.

On motion, the Secretaries were authorized to furnish back volumes and numbers of Transactions and Proceedings to the Johns Hopkins University.

A letter requesting information was received from the Oneida Historical Society, dated Utica, New York, Jan. 29.

A letter respecting the discovery of Penn MSS., and requesting information was received from John Lyon Denson, dated 21 Upper Northgate Street, Chester, England, January 11. The subject was referred to the Secretaries to report action.

Donations for the Library were received from the government of the Dutch Colonies and the Society at Batavia; the Geological Survey of India; the Imperial Austrian Academy; the Statistical Bureau of Sweden; the German Geological Society; Fortschritte der Physik and Garten Zeitung; the Leo. Car. Academy of Science; the Geological Society at Dresden; the Societies at Greifswald, Freiburg and Bonn; the Danish Academy and Society of Antiquaries; the Belgian Academy; M. Henri de Saussure, of Geneva; the Academia dei Lincei; the National Academy and Geographical Society at Bordeaux; the Zoölogical and Anthropological Societies and Ecole Polytechnique, Revue Politique, and Science et Nature; the Meteorological and Astronomical Societies in London, and London Nature; Dr. T. S. Hunt; the Boston Natural History Society, and American Academy of Sciences; the Museum of Comparative Zoölogy, and Cambridge Observatory; Magazine

of American History; Franklin Institute, Academy of Natural Sciences, Board of Health, Richard Vaux, Lorin Blodget and H. Phillips, Jr.; the Johns Hopkins University; U. S. National Museum; Dr. Peter, of Frankfort, Kentucky; Isaac Smucker, of Newark, Ohio, and the Statistical Bureau of Mexico.

Professor Cope exhibited specimens and described his classification of the fossil *Creodonta*.

The President reported that he had appointed the following Standing Committees for 1884:

Finance.

Eli K. Price, Henry Winsor,
J. Price Wetherell.

Publication.

D. G. Brinton, G. H. Horn,
C. M. Cresson, Persifor Frazer,
J. Blodgett Britton.

Hall.

J. Sergeant Price, Wm. A. Ingham,
C. G. Ames.

Library.

E. K. Price, Henry Phillips, Jr.,
E. J. Houston, Wm. V. McKean,
Thomas H. Dudley.

The President reported that he had received and passed to the Treasurer the quarterly interest of the Michaux legacy, last due, amounting to $133.07.

The Committee on Aztec MSS. reported that they had reclaimed some of them for publication.

Mr. Phillips offered a resolution respecting the order of business, which was, on motion, referred to the Board of Officers and Council.

Stated Meeting, February 15, 1884.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Messrs. Parrish, Ashhurst and Cohen, new members, were introduced to the presiding officer and took their seats.

Dr. Maisch accepted membership by letter, dated Philadelphia, February 17.

Letters respecting missing publications were received from the Batavian Society at Batavia, the Geological Society of France, and the Johns Hopkins University. (See rough minutes.)

Letters of enquiry respecting publications were read from Mr. D. Lyman, of the U. S. Revenue Department, and Prof. A. L. Guss, of the U. S. Treasury Department; and a letter of envoy from Col. Jas. Worrall, of Harrisburg.

The Lee MSS., 2 Vols., having been returned to the Library, the Librarian read a letter of explanation from Mr. Justin Winsor, dated Cambridge, Mass., Feb. 9.

Donations for the Library were reported from the Geological Survey of Victoria; Revue Politique; Geographical Societies of Paris and Bordeaux; Annales des Mines; R. Academy of History, Madrid; Revista Euskara; London Nature, R. A. Peacock, and B. Ward Richardson; the Glasgow Philosophical Society; the Geological Survey of Canada; the Boston Natural History Society; Museum of Comparative Zoölogy; American Antiquarian Society; American Journal of Science; Astor Library; Academy of Sciences and Prof. J. S. Newberry, of New York; American Journal of Pharmacy, and Numismatic and Antiquarian Society; Col. Jas. Worrall, of Harrisburg; the U. S. Naval Institute; the U. S. War Department, and Mr. H. Phillips, Jr.

The death of Arnold Guyot, at Princeton, N. J., February 8, 1884, aged seventy-six years and four months, was reported,

and the President requested to appoint a member to prepare an obituary notice of the deceased.

An obituary notice of Dr. Robert Bridges was read by Dr. Ruschenberger.

Mr. Blodget described the transfer of certain manufacturing industries from England to Philadelphia.

Sections of the Anthracite Coal Measures, recently executed by the Geological Survey of the State, were exhibited.

Dr. Frazer exhibited copies of prehistoric hieroglyphs, found in the Puerco San Antonio, Coahuila, Mexico, 25 S. E. of Coahuila, not previously described, sharply cut. Also, his discovery of a granite sacrificial stone, of great weight and age, lying sixty or seventy miles distant from any rock of that kind in the region. Size, 5′, 6″ by 3′, and 4′ high; shape peculiarly curved; edges full of fine sharp serrations; weight at least five and a half net tons. A natural ravine cut in the stone would allow the blood to flow off without overflowing the stone. The locality is a narrow mountain pass, which has a history both ancient and modern.

The minutes of the last meeting of the Board of Officers were read and their consideration postponed.

The Committee on Aztec MSS. reported progress.

Stated Meeting, March 7, 1884.

Present, 12 members.

Vice-President, Eli K. Price, in the Chair.

Mr. Lehman, Mr. Isaac Burk and Professor Pancoast were introduced to the presiding officer, and took their seats.

Acceptance of membership was reported from Dr. Ellerslie Wallace, Dr. J. Solis Cohen and Lord Coleridge.

Letters of acknowledgment were received from Le Ministère des travaux publics (Annales des Mines), February 4

i; want XIV, ii, and 97 and 100); the Society of Nat-
cience, Cherbourg, January 31 (113; want 16, 37, 46);
yal Institution, London, February 2 (XVI, i, 113); the
y of Antiquaries, London, February 20 (XVI, i, 113); the
rsity Library, Cambridge, February 14 (113); Radcliffe
ratory, March 7 (XVI, i, 113); Cambridge Philosophical
y, February 11 (XIII, i; XIV, ii; XVI, i, 62, 71-3,
Essex Institute (114); New Hampshire Historical So-
Concord (114); American Antiquarian Society, Worces-
ass. (114); Brown University (114); Connecticut His-
Society (114); W. P. Blake, New Haven (114); Uni-
r of the City of New York (114); Prof. J. J. Stevenson
Astor Library (114); United States Military Academy
Chemical Society, University Building, Washington
e, New York (114); New Jersey Historical Society
Historical Society of Pennsylvania (114); Numismatic
ntiquarian Society of Philadelphia (114); Mr. Henry
os, Jr. (114); Prof. Thomas C. Porter, Easton, Pa. (114);
ning Historical and Geological Society (114); Rev.
A. Murray, D.D., Carlisle, Pa. (114); Asaph Hall,
ington (114); Theo. Gill, Washington (114); William B.
r, Washington, D. C. (114); J. M. Hart, Cincinnati (114),
e University of Michigan (114).

ers of envoy were received from the Philosophical So-
Washington; the Netherlands Legation and Henry B.
n, of Morrisania, N. Y.

ations to the Library were reported from the Asiatic
y of Japan; the Society at Wiesbaden; Royal Acade-
Brussels; Flora Batava; Royal Academy, Rome; Geo-
ical Society, Bordeaux; Geographical and Ethnographi-
cieties at Paris; Revue Politique; Congrès des Orient-
; Royal Astronomical Society and London Nature; Geo-
l Survey of Canada; Essex Institute; B. S. Lyman, of
ampton, Mass.; Museum of Comparative Zoölogy; Har-
Jniversity; Prof. Henry Draper; Boston Society of Nat-
History; Science Record; American Journal of Science;
o Society of Natural Sciences; Franklin Institute;

American Journal of Pharmacy; Pennsylvania Magazine; American Bar Association; Mercantile Library, Philadelphia; Haverford College; Wyoming Historical and Geological Society; Second Geological Survey of Pennsylvania; Pennsylvania Secretary of Internal Affairs; Richard Vaux, of Philadelphia; American Journal of Mathematics; United States Light-house Board; Bureau of Education; Dr. Hayden's Geological Survey; Colonel Charles W. Whittlesey; American Antiquarian Society, Chicago; Richard Mansill, Rock Island; the University of Michigan; Wisconsin State Historical Society; and the San Francisco Mercantile Library Association.

A letter from Mr. Jedediah Hotchkiss, Staunton, Va., was read, requesting permission to have photographs taken of the plates of the Natural Bridge from DeChastellux's Travels in North America; the photographing to be done in the rooms of the society. On motion, the request was granted.

The death of Prof. George Englemann, at St. Louis, February 11, aged seventy-five, was announced.

Mr. Lesley was appointed to prepare an obituary notice of Professor Guyot.

Professor Cope read a paper entitled, On the structure of the skull in the Elasmobranch genus *Didymodus*.

Mr. Ashburner presented some notes "On aneroid hypsometry," and exhibited a self-registering field instrument.

Mr. Hotchkiss explained his request regarding pictures of the Natural Bridge, and spoke of the fine photographs recently made of it by order of Mr. Kemble, 333 Walnut street, Philadelphia.

Pending nominations, Nos. 1012, 1013, and new nominations, Nos. 1014, 1015, were read.

OBITUARY NOTICE OF DR. ROBERT BRIDGES.

By W. S. W. Ruschenberger, M.D.

(Read before the American Philosophical Society, Feb. 15, 1884.)

A man whose honest conduct and toil through a long life ıtribute, in any marked degree, towards the comfort, or enhtenment of his fellows, or the good name of the community which he lived, earns a claim to kindly remembrance after has left the field of his labor forever. It is good for the livg to know something of his ways and services, though he may ıt have won a foremost place among the leaders of science or letters. Even an imperfect sketch of the life of a man who ıs striven to increase or to diffuse knowledge, is more or less ıluable, because it may incite others to emulate his example, ıd toil patiently among followers till qualified to fill a chief's ıce. If the reputation of a workman is in proportion to the ality and quantity of his work, then a fair relation of what . Bridges has done will suffice to secure, without aid of rhetc, the degree of encomium which his life deserves in this nection. A kind and generous disposition enhanced the rit of his work. He did much that brought no pay beyond satisfaction which comes from doing to help others, and to tribute to the common progress. His life was characterized uniform, unremitting labor.

The details of this sketch may be somewhat tiresome, but as y contain the gist, all the testimony in the case, they may patiently heard at least, if not excused.

The ancestry of Dr. Robert Bridges is traced to Edward idges who, in 1648, was a lieutenant of the English army. ward, his eldest son, who was an architect, married in 1692. e left two sons. The elder, named Edward, married Cathene Bullen. He was a merchant in Cork. He had six sons ıd two daughters. Edward, the eldest of the sons, who also as a merchant in the city of Cork, married a second wife in otterdam, Cornelia, the second daughter of Thomas Culpeper, f Kent county, England. By her he had four children.

Edward, their third son, settled in Philadelphia, and, in 1739, was established at a corner of Front and Walnut streets, in the dry goods trade. His place of business was commonly called "the Scales."

He left three sons: Edward John, who was born in Rotterdam, in 1736, and died in Jamaica, surgeon of the *Africa*, a sixty-four gun ship; Culpeper, who died a midshipman on board of the *Northumberland*, at the siege of Louisburg, Cape Breton, 1758, and Robert, who was born in Philadelphia, November 18, 1739, and married, in 1769, Jemima Sheppard, of Bensalem township, Bucks county, Pa. He had five sons, Barnsley, Robert (who probably died young), Culpeper, Robert and Edward; and five daughters, Cornelia, Mary, Sarah, Harriet and Emily.

Robert Bridges was a sailmaker. His residence was at (old number) 259 South Front street, and his sail-loft was on the wharf, Delaware avenue, north of Lombard street. James Forten, an almost "colorless colored man," was his foreman, and, in 1800, when Robert Bridges died, succeeded him in business.

Culpeper Bridges, the third son of Robert, the sailmaker, was born in Philadelphia, December 21, 1776, and died December 29, 1823. He was trained to be a merchant by John Leamy, whose "counting-house" was at the south-east corner of Walnut and Third streets. He married, February 21, 1804, Sarah, the fifth daughter and eleventh child of William Cliffton, of Southwark, a blacksmith and machinist, and had two sons, William Cliffton, and Robert, the subject of this sketch, who was born in Philadelphia, March 5, 1806.

We are what our mothers make us, and therefore it seems proper to state that the iron master, William Cliffton was born, probably in Philadelphia, March 4, 1729, and died February 24, 1802. He married, September 2, 1763, Catherine Hallowell, by whom he had twelve children in the course of less than nineteen years. She died July 16, 1786. They were all members of the Society of Friends. One of the sons, William, who died November 25, 1799, was a poet as well as blacksmith. It

was said that he was "read out of meeting," expelled from the society, for the reason that he indulged in the frivolity of writing verses. If no other cause of expulsion existed, it is demonstrable that Friends of the present time are not so austere as they were then. But there is proof that other reasons probably influenced the decision. The preface of a volume of "Poems, chiefly occasional, by the late Mr. Cliffton," printed for J. W. Fenno, in 1800, claims that he was "an expert swordsman, a scientific and admirable musician, an accomplished painter and a graceful dancer," clearly showing that his acquirements were of a kind not likely to be commended in the community of Friends.

William Clifton, blacksmith, resided, 1785, in Water street between Almond and Catharine streets,* and in 1797, at No. 74 Swanson street.† About this date he seems to have transferred his business to his sons, William and John, for the City Directories of 1798, and subsequent years, give his residence at No. 76 Swanson street, and style him "gentleman," a term used in those days to designate a man of income sufficient to live at ease without work or a vocation.

This outline of lineage, which is purely English, implies that the ancestors of Dr. Bridges were vigorous, enterprising, intelligent, industrious and respectable.

Both sons were liberally educated, both were pupils in the University Grammar School. William Clifton graduated from the department of arts of the University of Pennsylvania in 1821. Robert was for a short time one of the sophomores of the University—there was no freshman class at that period—and then, for no assigned reason, entered Dickinson College, Carlisle, Pa., from which he graduated 1824. In July of the same year he was elected a member of the Societas Philosophiæ Consociata of the College.

Immediately after his return to Philadelphia he became a pupil of Dr. Thomas T. Hewson, and remained under the

* The Philadelphia Directory, by Francis White, made up to September 1, 1785. It was the first work of the kind published in the city. Up to that time numbers had not been attached to the houses.

† Philadelphia Directory, by Cornelius William, Stafford, 1798, 1802.

instruction of that eminent medical teacher and surgeon nearly four years. He had associated with him, in teaching his large class of students, several assistants. His office was a two-storied house, on the north side of Library street near to Fourth street. In it were a students' reception-room, a laboratory and a lecture room, and, in the rear of the house, a dissecting-room.

In Dr. Hewson's private medical school Dr. Franklin Bache taught chemistry. He appointed young Bridges his assistant very soon after he began his medical studies. In this capacity he served Dr. Bache through many years, in the courses of chemical lectures delivered by him in the Franklin Institute, in the Philadelphia College of Pharmacy, and at the Jefferson Medical College. This practical training made him an expert chemist and an admirable teacher of chemistry.

His close attention, habitually given to whatever he might be doing, qualified him in a high degree to assist the lecturer on chemistry. In May, 1827, upon pouring water into an iron mercury flask, which had been used for obtaining oxygen from nitre, for the purpose of washing it, he noticed a lively effervescence. He proceeded at once to investigate the nature of the gaseous matter, and found it to consist of oxygen of a purity of ninety-five per cent, as he ascertained by Dr. Hare's accurate sliding-rod endiometer. He observed the same phenomenon, November 27, at the Franklin Institute, and found in this instance that the oxygen contained only one per cent of impurity. He suggested that this residuum, which Dr. Hare conjectured to be peroxide of potassium, would furnish pure oxygen to the experimenter without trouble. He was anticipated in this discovery. Mr. Richard Philips, of London, had made the same observation and given the same rationale of the phenomenon, an account of which he published in the *Annals of Philosophy*, for April, 1827. Nevertheless, Dr. Franklin Bache, published in the *North American Medical and Surgical Journal*, for January, 1828, a note of the observation of "Mr. Robert Bridges, student of medicine," on the "Residuum of Nitre after exposure to red heat."

The circumstance indicates his character as a student and at the same time Dr. Bache's kind appreciation of his worth.

Dr. Bridges graduated from the medical department of the University of Pennsylvania, March, 1828. "Neuralgia" was the subject of his thesis.

He immediately opened an office at the south-east corner of Vine and Thirteenth streets, where he remained till 1837. He did not obtain a lucrative practice. His mother died, February 19, 1839, in the fifty-eighth year of her age, a loss generally among the saddest in man's experience.

A carefully prepared tabular record of 2099 cases of vaccination under his observation, between April 1, 1830, and May, 1840, indicates that he was a vaccine physician of the south-western district of the city during ten years. An ordinance of January 2, 1830, divided the city into four districts, designated as the North-eastern, North-western, South-eastern and South-western Districts, and directed the Mayor to appoint a vaccine physician to each on the first Monday of January every year.*

The Board of Health appointed Dr. Bridges, July 17, 1832, the cholera year, one of the attending physicians in the district which included the Eastern Penitentiary, then at the north-west corner of Broad and Arch streets. The work was arduous. Entire nights were passed in the prison ministering to cholera patients. The remuneration for this perilous service was very small.

Dr. Bridges was a constituent member of the Friday Evening Medical Club, which was formed in 1835 or '36, and ceased to exist about 1872. The meetings were held, in turn, at the houses of the members. The entertainment was limited to tea, coffee and biscuits. The object of the club was to promote social intercourse among members of the medical profession in the city.

He was elected a member of the Academy of Natural Sciences of Philadelphia, January 1835; of the Franklin Institute, Jan-

* Vaccine physicians were appointed in the Northern Liberties under an ordinance of May 15, 1820, and in Kensington, under an ordinance of December 4, 1823.

uary, 1836; a resident member of the Philadelphia College of Pharmacy, December, 1838; a fellow of the College of Physicians of Philadelphia, July, 1842; and he was chosen a member of the American Philosophical Society, January 19th, 1844.

He was a councillor of the Society from January, 1855; chairman of its publication committee six years, from 1860, and served on many special committees.

His first work in the Academy of Natural Sciences was the preparation, in conjunction with Dr. Paul B. Goddard, of an Index of the genera of the Herbarium, which was presented August, 1835. He served on the Botanical Committee twenty-one years, from January, 1836. In May, 1843, he presented a new Index of the Academy's Herbarium, and an Index of Menke's Herbarium, works which were long the main guides to the Academy's botanical collections.

He was librarian from June, 1836, till May, 1839, when he resigned. The thanks of the Society were presented to him for "his able and efficient discharge" of the duties of the office.

He served as Recording Secretary five months in 1839 and '40; and as Corresponding Secretary from May, 1840, till December, 1841. He was an Auditor six years, from December, 1843, one of the Vice-Presidents more than fourteen years, from September, 1850, and was elected President, December, 1864. He declined re-election December, 1865.

He served twenty-three years on the Publication Committee, declined re-election in 1872; twenty-nine years on the Library Committee, from December, 1842; seven years on the Committee on Proceedings; five years on the Committee on Finance; seventeen years on the Committee on Entomology and Crustacea. He labeled and arranged anew the collection of crustacea according to the nomenclature and classification accepted at the time as the best. He was a member of the Committee on Herpetology and Ichthyology nine years, from January, 1857; on Physics ten years, from January, 1866; on Chemistry five years, from December, 1870, and a member of the Council more than five years, from December, 1869.

When the Academy's building was extended in 1846, and the extended building was raised and improved in 1855, he served on the building committees, and aided in obtaining subscriptions for the work on both occasions.

Again, December, 1865, Dr. Bridges was appointed a member of a committee to solicit subscriptions to erect a fire-proof building for the use of the Academy; and, January 8, 1867, he was elected one of the Board of Trustees of the Building Fund, and by it a member of the Building Committee, January 11, 1867, on which he served faithfully until the Society was established in its new quarters, January, 1876.

The official positions to which he was annually elected, his appointment to several standing and many special committees, imply that he had the respect and unreserved confidence of his fellow-members. Among them none was more constant, none who worked more industriously. He promptly discharged all duties imposed upon him and, during forty years, was seldom absent from the meetings of the society. In addition to his valuable services, he contributed to its funds, to its library and its museum as liberally as his modest income justly allowed.

As a token of their estimate of his worth, a number of members presented to the Academy a portrait of him which, painted by B. Uhle, an eminently skillful young artist of this city, will soon be hung in place among the portraits of the presidents of the society.

His remarks "On infusoria found in stagnant water" are reported in the Proceedings of the Academy for May, 1842; on "The influence of the contact of copper in preserving human bones," and on "Indian reliques," May, 1843; on "Estimates of the length of the year," and on the "Formation of lithoid carbonate of iron," in the volume for 1848.

At the Franklin Institute Dr. Franklin Bache taught chemistry, as lecturer and professor,* from September, 1826, till 1831. During the whole period, five years, Dr. Bridges was his assistant. After that time he did not participate in the

* Dr. Bache was appointed lecturer on chemistry, September, 1826, and professor, March, 1828.

proceedings of the Society though he was occasionally present at its meetings.

As already stated, he was an active and prominent member of the Academy of Natural Sciences, but all his time was not given to it. He labored most earnestly in another institution, the Philadelphia College of Pharmacy, with which his career was so closely associated, that, to understand it clearly, a statement of the circumstances which attended the origin and progress of the College seems necessary.

A National Convention of Physicians assembled at Washington, D. C., January 1, 1820, for the purpose of devising a code of formulas, and establishing it as the sole standard for medicinal preparations. The object was to have them made exactly alike in composition and strength by all physicians and apothecaries throughout the land.

At that period the London, the Edinburgh, the Dublin and other pharmacopœias were recognized authorities in the United States. Their directions were not alike. Therefore, as every apothecary followed the standard he considered best, officinal preparations of the same name, found in the shops, differed from each other just as the standards differed. The composition and potency of the physician's prescription were contingent, in an important degree sometimes, upon the pharmacopœia followed by the apothecary who dispensed it.

It is obvious that the interest of both patients and physicians required that these several authorities should be superseded by a single standard. To attain this end, to establish a permanent authority in the premises, and obtain for it general confidence and respect everywhere in the United States, it was determined that a national convention composed of delegates from the medical colleges and incorporated medical societies of the country should be convened every tenth year; that each delegation should be invited to submit to the convention a report of suggested amendments to the work; that from the reports presented the convention, through the agency of a select committee appointed for the purpose, should compile and publish a revised edition of the Pharmacopœia every ten years. An

advantage of this plan is, that each revision represents at the date of publication the common opinion of the profession, and the work is kept in accord with the progress of pharmacy and of medical knowledge.

The result of the labors of the convention of January, 1820, was the publication, at Boston, Mass., December 15, 1820, of the first Pharmacopœia of the United States of America, and since, of decennial revisions of it, the sixth of which is now in use.

The achievement is notable. The pharmacopœia of every nation of Europe is a public work directed and paid for by the government. Without the influence of a statute of any kind to sanction or enjoin its use, this, through the force of public opinion created in its favor, has been established as the law, the standard in the premises, which is generally respected.

The work is purely charitable. It has been done, for three-score years at least, at the cost of the labor, time and money of many medical men without any compensation to the workmen for their work; and the results of it have been freely given for the common good.

Dr. Bridges was among the most skillful of those who labored to perfect the Pharmacopœia. The Philadelphia College of Pharmacy appointed him, March, 1847, one of a committee to revise the issue of 1840, and prepare the report on it to be given to the National Convention of 1850, the first in which pharmacists were represented. He assisted on a committee of the College of Physicians, appointed February, 1868, to report on the fourth decennial revision; was one of the delegates from the college to the meeting of the National Convention of 1870, and was a member of the committee on publication of the fifth decennial revision. In July, 1877, the College of Physcians appointed him one of a committee to revise the Pharmacopœia of 1870, and prepare a report on it for the National Convention of 1880.

The labor of those committees of revision is considerable. Inspection of materials, pharmaceutical experiments and therapeutic observation are often necessary to determine the value

of a formula. Each committee held weekly sessions of about two hours, and, on an average, required two years to complete its work. All the institutions which participate in the preparation of a revised edition of the Pharmacopoeia, give it like attention, so that it is not easy to conjecture the aggregate of labor bestowed upon it. So much care merely signifies that, in the estimation of the profession, accuracy in all the details of the work is very important.

About the time when the first National Convention met, the drug and apothecary business was regarded as a trade, rather than as a profession based on scientific principles, as it is now. It was known that deteriorated drugs were sold, and that valuable preparations in daily use were adulterated or made of materials of inferior quality. Such abuses were charitably ascribed to ignorance of pharmacy which was supposed to prevail among druggists and apothecaries generally.

To remedy this lamentable condition of the apothecary's vocation, some three-score of intelligent, philanthropic men, including a large proportion of members of the Society of Friends, associated in this city and founded, February 23, 1821, the Philadelphia College of Pharmacy, a society which was incorporated, March 30, 1822, with all legal authority necessary to establish and support a school of pharmacy.

The University of Pennsylvania had then recently provided for teaching pharmacy in connection with materia medica, and conferring the degree of Master of Pharmacy, which was conferred the first time in the spring of 1821 on sixteen graduates. This action of the University, it was said, greatly influenced, if it did not determine the formation of the Society known as the Philadelphia College of Pharmacy.

It consists of active or resident, honorary and foreign members. The conduct of its ordinary affairs is confided to sixteen trustees, one-half of whom are elected semi-annually by the college. The stated meetings of the board of trustees are monthly, and of the college, quarterly.

The first courses of lectures, which were limited to materia medica and chemistry, were given in the winter of 1821–22,

but the degree of "graduate of pharmacy" was not conferred till the spring of 1826, when there were three graduates.

The lectures were delivered in a building on the west side of seventh, between Market and Chestnut streets, the site of which is now occupied by the Gas Office of the city.

In 1832 the society erected for its use a building on the south side of Zane, now Filbert street, west of Seventh, and occupied it until the college was established in its present well adapted quarters, No. 145 North Tenth street, September, 1868.

Under the authority of the Society, the *American Journal of Pharmacy*, which is devoted to the advancement of pharmaceutical knowledge, and the advocacy of thorough education of pharmacists, was established in 1825. It was issued quarterly, till 1853, then bi-monthly till 1871, since that date monthly, and continues to be a prosperous periodical.

Dr. Bridges was assistant editor of this journal about six years, from 1839 till 1845, and contributed several original papers to it.

The college grew very slowly. But the strict probity observed in its management and the great care taken to select only the most competent and conscientious teachers, have enabled it to surmount all impediments in the way of its progress.

Now, graded courses of instruction are given on materia medica, botany, the theory and practice of pharmacy, chemistry (practical and analytical), and pharmaceutical manipulation, by a faculty consisting of four professors and three assistants. The teaching is very thorough. Since the establishment of the school 7109 students have matriculated; upon 2049 of whom, 28.82 per cent., the degree of graduate in pharmacy has been conferred.*

Dr. Bridges entered the college, May, 1831, as private assistant of the professor of chemistry, Dr. Franklin Bache, and was elected an active member of the society December 18, 1838, and, March 25, 1839, a member of the Board of Trus-

* Sixty-third Annual Announcement of the Philadelphia College of Pharmacy, 1883.

tees, and also of the Publication Committee, to which he was annually elected, till 1861, twenty-one years, when he declined re-election. He was elected chairman of the Board of Trustees, October 9, 1860, and, being annually re-elected, held the position till the close of his life.

When Dr. Bache gave up the chair of chemistry to take the professorship of the same department in the Jefferson Medical College, Dr. Bridges was a candidate for the vacant place, but Dr. William R. Fisher was elected, May 31, 1841, by a majority of two votes. He resigned the following April, and Dr. Bridges was unanimously elected Professor of General and Pharmaceutical Chemistry, May 16, 1842. Still he continued to be the private assistant of Dr. Bache, till his death, in 1864, severed their continuous laboratory association of forty years. Dr. Bridges, also aided Dr. George B. Wood in his work while he held the professorship of materia medica in the University of Pennsylvania, from 1835 till 1850.

Besides the routine work of the professorship, Dr. Bridges did his full share on standing and special committees, delivered many introductory and other addresses, and represented the College among its delegates to the American Pharmaceutical Association and other bodies.

It is related substantially that, prior to 1851, the average number of graduates annually, from 1826, was less than seven, and that the public commencements were biennial. That year the matriculants numbered 82, and the graduates 19. The class determined that the commencement should be attended with more demonstration than had been made on previous occasions. The ceremonies had been conducted in an apartment of the college, not capable of seating comfortably a hundred persons. Other arrangements were proposed, but opposition to them from an unexpected quarter was strong. The president and some of the trustees of the college belonged to the Society of Friends. They are notably conservative of their customary ways and averse to ostentation. The commencement had consisted in the delivery of diplomas to the graduates by the president according to a prescribed form, and a suitable

address by a professor in the presence of invited friends. The ceremony was sedate, without manifestation of that sense of triumph which successful young candidates are supposed to feel on such an occasion. As many Friends regard the fine arts, painting and sculpture, as frivolities, things not only unnecessary to happiness, but in their influence detrimental in some indefinite way to a proper observance of purely moral life; and music, by its charms, as likely to allure to evil ways, to divert the mind from industry and the pursuit of substantial things, their aversion to the proposed display was entirely in harmony with their ancient opinions in this connection. Rather than assent to the proposed arrangements some of them resigned, or purposely were absent.

Nevertheless, the commencement was held, April 4, 1851, in Sansom Street Hall, in the presence of a large audience, attended by a band of good music. Those most concerned were highly pleased. The vacancy caused by the resignation of the president was well filled on the occasion by Dr. Bridges, who conferred the degree of "graduate of pharmacy" on those entitled to the honor.*

The painstaking and kindly ways of Dr. Bridges in teaching, won for him affectionate and enduring respect from those whom he taught. At the commencement, March, 1867, a portrait of him, in oil, was presented to the college by the Phi Zeta Society; and the graduating class, at the commencement, March, 1877, presented to him a stem-winding gold watch.

The additional labor imposed by adopting the method of teaching in graded courses, induced Dr. Bridges, in June, 1878, to procure an assistant. And in January, 1879, at a meeting of the Board of Trustees, he stated informally that his impaired health constrained him to announce that he would relinquish the chair of chemistry at the close of the course.

On hearing of his intended resignation, the graduating class of one hundred and fourteen members, representing eighteen States, held a meeting and adopted a preamble and resolutions,

*See The Annual Address before the Alumni Association of the Philadelphia College of Pharmacy. By James Stratton, Ph. G., 1879.

expressing regret, sympathy, and, for themselves as well as their predecessors, "profound respect for Dr. Bridges as a chemist, and their most grateful esteem for him as their friend and instructor," and earnestly invoking the divine blessing upon his remaining years.

He tendered his resignation in a letter dated March 4, 1879. At a meeting of the Board of Trustees, March 14, a preamble and resolutions were unanimously adopted, stating in substance that he had devoted his time and abilities to a conscientious discharge of the trust assigned him for a long period, during which the professors received a scanty remuneration, that "to his sound judgment and patient labor" the success of the college is much indebted; that the good work he has accomplished has its record in those who have been his pupils in the college—about five thousand—and that he has the sincere thanks and sympathy of the Board.

At the celebration of its twenty-fifth anniversary, March 1, 1879, the Phi Zeta Society, which is composed of alumni of the college, created a scholarship and named it the Robert Bridges scholarship, as a token of its high estimation of his character and official services.

The Board of Trustees after due deliberation, "in view of his faithful and efficient labors," conferred upon him, May 6, 1879, the title of Emeritus Professor of Chemistry, with an annual salary of one thousand dollars, to be paid in equal instalments quarterly, in advance, during his life, from the first day of July ensuing.

By this spontaneous act of benevolence, the Trustees have shown themselves to be worthy of honor as distinguished as that which they conferred on Dr. Bridges; and they have set an example eminently proper to be followed by all incorporated educational institutions. There are no skilled laborers whose work is more important to the community, and yet none so inadequately paid, as professors and teachers in our colleges and schools of every name. During the vigorous period of their lives their remuneration affords them and their families a very modest living; but it is too scanty to permit investment of a

part of it annually to create resources sufficient for invalid days and old age, even after continuous toil during thirty or forty years. Possibly better than increased remuneration for these beneficent servants of the people would be a college fund from which those professors who have become incapable of performing their official duties, by age or otherwise, might receive a moderate pension or retired pay; at any rate the emeritus professor should have a salary.

When the professorship of chemistry in the Jefferson Medical College was vacated, in 1864, by the death of the incumbent, Dr. Bache, Dr. Bridges was one of seven candidates for the vacancy. It was filled by the election of Dr. B. Howard Rand.

While discharging, efficiently and most acceptably, his duties at the Academy of Natural Sciences, and in the Philadelphia College of Pharmacy, he found time to teach medical chemistry in the Philadelphia Association for Medical Instruction, to attend the meetings of the American Philosophical Society, and of the College of Physicians of Philadelphia, and render to it valuable service. He was one of its delegates to the National Medical Convention held in Philadelphia, May, 1847, and subsequently was one of the representatives of the college in the American Medical Association.

He analyzed the collection of one hundred and eighty-five urinary-calculi in the Mütter Museum, which belongs to the college, and made a catalogue of them.

In January, 1867, he was elected a member of the library committee and appointed librarian. The duties of the office occupied him daily from 11 o'clock, A.M., till 3 o'clock, P.M. In January, 1879, he declined re-election to the library committee, and failing health induced him to resign the office of librarian, January, 1881, having filled it during fourteen years. Then, on motion of Dr. DaCosta, it was unanimously resolved "that the thanks of the college be tendered to Dr. Bridges, for his long, faithful and intelligent services to the college, and that they deeply regret that failing health will deprive the college of his labors; that as a slight token of ap-

preciation of his long services, his annual dues be hereafter remitted." And at its stated meeting, January 26, 1881, the library committee presented to Dr. Bridges "the expression of their sincere regret that the care of his health obliges him to retire from the office of librarian, which he has held for so many years, and in which they have learned to appreciate his industry, fidelity and courtesy. They sincerely hope that he may find in repose and recreation the means of improving his health, and the opportunity of observing the growth of the library with whose early history he has been identified."

Cultivation and teaching of the medical sciences have ever been among the pursuits which contributed to the good name of Philadelphia. The excellence of the medical colleges in the city is generally acknowledged. This high character is ascribable, in some degree at least, to aspiring young physicians who joined together in little bands to lecture and teach the several branches of medicine while the incorporated colleges were closed. In past times this recess continued during six or seven months of the year. Those engaged in the summer schools, as they were called, soon became trained teachers, well qualified to fill professorships. Several of the most distinguished professors in our medical colleges were partly indebted for their appointment to the preliminary training, and reputation acquired in a summer school.*

In the spring of 1842, the Philadelphia Association for Medical Instruction was formed. The constituent members or founders of it were Dr. John F. Meigs, who taught obstetrics till 1845, and afterwards lectured on the diseases of children; Dr. Joshua M. Wallace, who taught surgery; Dr. Robert Bridges, chemistry; Dr. Francis Gurney Smith, Jr., physiology; and Joshua M. Allen, anatomy. Dr. Bridges, was the only constituent member of the Association who remained in it until it was dissolved at the close of 1860, a period of eighteen years.

*The History of the Philadelphia School of Anatomy and its relations to medical teaching. A lecture delivered March 1, 1875, at its dissolution. By William W. Keen, M.D. (published by J. B. Lippincott & Co.).
Many of the associations for medical teaching in Philadelphia are sketched or referred to in this very interesting paper.

Several retired to accept professorships in medical colleges, and their places were supplied by new appointments, so that during the career of the Association the names of many distinguished physicians are recorded on its list of members.*

Dr. Bridges was elected professor of chemistry in the Franklin Medical College in 1846, and filled the office till the institution was dissolved in 1848.

His contributions to medical and scientific literature are valuable, but not very numerous.

His papers in the *American Journal of Pharmacy* are entitled, "Chemical symbols," and "Pyroacetic spirit and its derivative compounds," in 1839; "The manufacture of sulphuric acid," and the "Adulteration of lac sulphuris," in 1840; "Notice of Professor Kane's researches on ammoniacal compounds," "Poisoning by long continued use of acetate of lead," in 1841; "Observations on two species of aristolochia which afford serpentaria," "Observations on the action of ether on galls," "Report on Procter's hydrated peroxide of iron," in 1843; "Experiments on the absorbing power of anthracite," "Precipitated carbonate of lime," "Solution of iodide of iron," "Solidification of carbonic acid," in 1844; "Pil hydrargyri," in 1846, and "Southern prickly-ash bark," in 1865.

In July, 1845, Dr. Bridges "edited with additions" the American reprint of Elementary Chemistry, Theoretical and Practical, by George Fownes, and subsequently several editions of this popular volume. The latest American, from the twelfth English edition of the work, was issued May, 1878.

He also edited, 1852, the American reprint of Graham's Elements of Chemistry.

From 1854 till 1877, inclusive, he contributed very many bibliographical notices and reviews, chiefly of works on chemistry, to the *American Journal of the Medical Sciences.*

* David H. Tucker, William V. Keating, J. H. B. McClellan, Ellerslie Wallace, Addinell Hewson, John H. Brinton, S. Weir Mitchell, Alfred Stillé, Morton Stillé, J. M. DaCosta, Francis West, James Darrach, and Edward Hartshorne, were teachers in this Association. Including the constituent members, a corps of better qualified instructors than those associated in this summer school could not be easily found anywhere.

He assisted Dr. George B. Wood in the preparation of the twelfth, 1865, the thirteenth, 1870, and the fourteenth, 1877, editions of the United States Dispensatory, a leading work on materia medica and pharmacy of such acknowledged excellence and accuracy as to be generally accepted as authority in the premises.

During the last few years of his life, Dr. Bridges endured most patiently the constant molestations and frequent pain which attend chronic cystitis. His repose at night, broken into a series of hourly naps, did not bring to him for the next day the refreshing effect of normal sleep ; and so his physical vigor was continuously abated, and his mental pursuits greatly disturbed. But in spite of worry from this condition of his health, he was serenely cheerful and manifested his usual interest in scientific topics.

Within a few days of the completion of the seventy-sixth year of his age, he died, February 20, 1882, in the house he had occupied with his brother and family twenty-eight years.

He was never married. His generous and sympathetic kindness, self-sacrificing spirit and habitual amiability won the almost filial love and respect of his brother's many children. Their devotion to him is conclusive evidence of the excellence of his domestic qualities and the tenderness of his nature.

Frugal in his living, punctual and loyal to all duties, accurate, learned, unremittingly industrious, rigidly self-respecting and pure in conduct in every sense, he worked faithfully throughout his long life, but did not reap compensation commensurate with his toil. He lacked of that self-asserting, aggressive spirit which leads many a good man to fortune under circumstances in which one of far greater intrinsic worth often fails only because he is too shy, too modest to assert his claims to consideration. He was always content to leave to others the appraisement of his worth.

Without being ready in debate or at all eloquent in speech, he was an admirable and efficient teacher, as thousands of his pupils can testify. They will teach his lessons and thus long

continue and expand the beneficent influence of his instruction and example.

Though he was baptized in the Protestant Episcopal Church, and was occasionally present at its services, he seemed to hold views in harmony with the tenets of the Society of Friends, of which his mother and her ancestors were members. As long as the golden rule squared and regulated the daily practice of his life, the sunday observance of church ceremonies and listening to continuously iterated inculcations were insignificant, and, to our philosopher, seemingly without profit of any sort. The purpose of his life was to learn truths demonstrable to the senses. Of the kind of palpable truth, which is patent to the expert naturalist who perceives that the Creator is everywhere present in all His works, the church rector does not often speak; and if he did, could teach him nothing. To one earnestly engaged in the study of God's visible works, the attractions of pulpit teachings are comparatively feeble. To him doctrines and dogmas of every kind, though he may complacently listen to them, are of very small importance, because he knows that all doctrines and theories are unstable, and that the ascertained facts of the creation are permanent forever. He lived and believed as a christian, but without adhesion to any sect.

Dr. Bridges was notably reticent about himself among his most intimate friends. He left no letters or papers bearing testimony to his merits. A friend who had been intimate with him during a third of a century, says, in a letter, September 10, 1881: "Few men in this world—and I have met many who are good and generous—have ever, in my judgment, with such self-sacrificing generosity, bestowed as heartily their sympathy and their best efforts to gladden the lives of those around them, as our friend Bridges has always done. And the quiet, earnest and unflagging way in which he has bestowed the best energies and all the small rewards of his life among his friends is beautiful to behold. * * * *

"I am quite surprised to hear that he is able and enjoys so much exercise as to go twice a day to the cool hall of the

Academy to read in the library. I am very glad of it, and, especially, as he will there have the benefit of the refreshing atmosphere of that large room; and will enjoy the very best thing for him, not infrequent meeting with old acquaintances, and always find most congenial topics of conversation. I never shall forget the force with which, before I was well acquainted with Dr. Bridges, an assertion of Leidy one day struck me. Leidy said, he thought he had as much broad and general knowledge and accurate learning as could be found among us, and that he was a man of most sound and solid judgment. This I have found to grow upon my convictions of his mind and acquirements for the period of thirty-three years since Leidy spoke of him so sincerely and soundly."

His knowledge of natural history in general was extensive, accurate and always at command. He was a well-informed botanist, thoroughly versed in materia medica and chemistry, and a skillful practitioner of medicine. Naturally modest, almost shy, his manner to strangers was somewhat reserved, but cordial with his friends, all of whom regarded him with affectionate respect, because they recognized his perfect integrity, sincerity, extensive learning and good sense.

In the annual oration before the Alumni Association of the Philadelphia College of Pharmacy, March 13th, 1882, Mr. Frederick B. Power, spoke of him, as follows:

"I cannot refrain from adding my tribute to the memory of him whose loss we have so recently been called upon to mourn —the late Professor Dr. Robert Bridges. His faithful teachings, during an unparalleled period of service of nearly forty years, will long be held in grateful remembrance by those who were permitted to listen to his instructions, while his generous and noble nature, so beautiful in its simplicity, so approachable and free from ostentation, had endowed him with attributes well worthy of emulation, and endeared him to his pupils by ties of affection which will be ever fondly cherished."

In his valedictory address to the graduates of the college, March 15th, 1882, Professor Samuel P. Sadtler said:

"The Philadelphia College of Pharmacy has just lost, in the

death of Professor Robert Bridges, her Emeritus Professor of Chemistry, one, who, while he added much to her present substantial reputation, will be remembered and revered by those who knew him, chiefly because of his eminently lovable and unselfish character, his devotion to duty, and his faithful labors for the institution with which he was so long and so honorably connected.

"If we, younger men, and especially you, young gentlemen, just about starting upon your life's career, will emulate these qualities of character, we may expect some day, when the curtain drops upon the drama of our life, to have it said of each of us, as it is now said of him, 'his was a noble life.'"

Addition to these just eulogies seems redundant. But truth suggests that the most tender and considerate of all the testimony of his worth should be recorded. The Philadelphia College of Pharmacy did not limit its manifestation of respect to memorial resolutions or laying flowers on his bier. Its sense of sympathy and regret was substantially expressed in a spontaneous act of pure generosity. It asked, as a privilege inuring to long and intimate fellowship, to be permitted to defray the expenses of his funeral and to pay to his heirs an extra quarter's salary of the emeritus professor. Such homage is rarely offered; and when offered is seldom declined, even by opulent people.

Stated Meeting, March 21, 1884.

Present, 6 members.

President, Mr. FRALEY, in the Chair.

An acceptance of membership was received from Prof. W. LeConte Stevens, dated the Packer Collegiate Institute, Brooklyn, New York, March 11.

Acknowledgments of the receipt of Proceedings were received from the Museum of Comparative Zoölogy (114);

W. L. Stevens (114); U. S. Naval Institute (114); Leander McCormick Observatory (114); Cincinnati Observatory (114); Dr. Robert Peter (114), the Chicago Historical Society (114); the Wisconsin State Historical Society; the Christiania University (112); the K. L. C. Deutschen Akademie at Halle (108, 110, 111, 112; wants 109), and the Natural Historical Society, Northumberland, &c. (XVI i, 114).

Letters of envoy were received from the K. L. C. D. Akademie, November 3, 1883; Prof. W. L. Stevens; the Proprietors of Locks and Canals on the Merrimac river; James B. Francis, of Lowell, Massachusetts (wants 75, 96); the Department of Internal Affairs of Harrisburg, Pennsylvania; and the Cincinnati Observatory.

Donations for the Library were received from the Egyptian Institute; the Society at Stuttgard; the Revista Euskara; Revue Politique, Geographical Societies of Paris and Bordeaux; J. A. K. Newlands and J. Hambden, of London; the R. G. S. Cornwall; Canadian Record; J. B. Francis, of Lowell; American Chemical Society; American Bookseller; W. L. Stevens; H. Phillips, Jr.; Second Geological Survey of Pennsylvania; U. S. Bureau of Education; T. Gill; American Chemical Journal; American Journal of Philology; University of Cincinnati; C. Whittlesey; Chicago Historical Society; A. T. Andreas, and the A. A. A. S.

The death of Dr. Alfred L. Elwyn, at Philadelphia, March 15, aged 80, was announced by Mr. J. S. Price, and, on motion, the President was authorized to appoint a suitable person to prepare an obituary notice of the deceased.

The Librarian reported that he had received from Dr. Brinton the trunk of documents mentioned in the minutes of April 6, 1883, and requested orders respecting its disposal.

Pending nominations Nos. 1011 to 1015, and new nominations Nos. 1016 to 1022, were read.

An obituary notice of Strickland Kneass, by Mr. Fred. Graeff, was read by the Secretary.

A communication was received from Prof. Claypole, of Oberlin, Ohio, entitled, "On the Clinton and other Shales,

&c., composing the Fifth Group of Rogers, in the First Survey of Pennsylvania."

The amendment of the Rules was referred to the consideration of the President.

The Committee on Aztec MSS. reported progress.

The Committee on the Michaux Legacy reported as follows:

That under last year's authority of the Society, the sum appropriated was expended in the delivery of fourteen lectures in the Fairmount Park, during last year, according to annexed schedule, to increased and interested audiences.

The Committee recommend that the like appropriation be made for the present year, of two hundred and eighty dollars, for fourteen lectures, according to schedule annexed, and fifty dollars for advertising.

Free Lectures in Fairmount Park on Botany and Tree Culture, by Prof. J. T. Rothrock, on Saturdays, at 4 P. M., 1884.

April 19. Relation of American forests to American prosperity.
26. Plant freaks.
May 3. Insects and plants.
10. Insects and plants.
17. How timber matures, how it decays and how to use it.
24. Natural selection as related to increase of plants.
31. What evolution has done for science and for education, and where its possibilities stop.
Sept. 6. Plants in literature and in superstition.
13. Plant life during winter.
20. Stray plants.
27. Bread plants.
Oct. 4. Water plants.
11. A talk about trees.
18. The extinct plants of our land.

Mr. Fraley announced that he would send to the Society an original copy of the draft of the agreement proposed to be executed between the City and the Society when the latter

entered into the tenancy of the building. It recites the status between the City and the Society, which has lasted until now.

Stated Meeting, April 5, 1884.

Present, 10 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Peabody Institute, Baltimore (110, 111, 113), the U. S. Surgeon General's office (114), and the Society at Winnipeg (114).

A letter of envoy was received from Dr. A. C. Fryer, dated Elmhurst, Wilmilon, Cheshire, England, March 10.

A circular letter from the Accademia dei Lincei, announced the death of its President, Sig. Quintino Sella.

Donations for the Library were received from the Academies, Societies and Observatories, at St. Petersburg, Moscow, Vienna, Berlin, Halle, Marburg, Turin, Bordeaux, Liverpool and Winnipeg; from the Swedish Statistical Bureau; from the Ethnological and Geographical Societies; the Museum of Natural History and Revue Politique, Paris; from the Royal Institution, Astronomical, Geographical, Asiatic and Geological Societies, A. C. Fryer and Nature; James Freeman Clarke, of Boston; James Hall, of Albany; the Rhode Island Historical Society; American Journal of Science; the New Jersey Geological Survey; the American Journal of the Medical Sciences; Academy of Natural Sciences; Franklin Institute; Dr. H. C. Chapman; Prof. Wm. Dennis Marks; H. Phillips, Jr.; the Johns Hopkins University; U.S. Fish Commission; Washington Philosophical Society; and the Illinois State Museum of Natural History.

Dr. John Curwen, of Warren, Pennsylvania, accepted the appointment to prepare an obituary notice of the late Dr. Kirkbride.

Mr. Lesley read Mr. J. F. Carll's correction of a wrong hori-

zon assigned to a specimen of *Eurypterus pennsylvanicus*, found 72′ + top of Pithole well, Venango county, Pennsylvania, which places it 167′ above top of Pithole (Berea) grit struck in the well; therefore, a considerable distance *beneath* the Garland or Olean (Pottsville conglomerate bottom member) conglomerate. In Proceedings American Philosophical Society, Vol. XVI, page 621, its horizon is wrongly made to be *above* the Garland conglomerate, and therefore in the Pottsville conglomerate No. XII. Mr. Lesley remarked that Prof. James Hall's description of this and other Eurypterids, beautifully drawn by Mr. Simpson of Albany, was about to be published in Report of Progress, P. 3, of the Second Geological Survey of Pennsylvania.

Mr. Blazius read a paper on the unhealthy conditions of certain portions of great cities, produced by prevalent winds from certain quarters, and on the necessity for providing for their inhabitants means of rapid transit to and from the surrounding country.

Pending nominations Nos. 1012 to 1022, were read.

And the meeting was adjourned.

Obituary Notice of Strickland Kneass. By Frederic Graff.

(Read before the American Philosophical Society, March 21, 1884.)

On the morning of January 14, 1884, one of the valued members of this Society, Mr. Strickland Kneass, died at his residence in this his native city. We realize with sincere regret the loss of one intimately identified with the local affairs of this city, and the valuable railroad interests of the State connected therewith, and present this brief sketch of his life, as a record of a worthy and useful man.

Mr. Kneass was born July 29, 1821. His father, Mr. William Kneass, was an engraver of some note, and for several years employed in that capacity by the Government in the Mint in this city.

Mr. Kneass obtained his early education under the care of Mr. James P. Espy, who was one of the first to devise and suggest the present methods of anticipating changes in the weather, though from the lack of telegraphic communication at that time they fell short of the completeness that they have since attained.

After leaving school Mr. Kneass decided to adopt the profession of Civil

Engineer, and an opportunity soon offered for the commencement of his practical training as such, under the care of his elder brother, Mr. Samuel H. Kneass, assisting in the surveys then making for the Delaware and Schuylkill Canal, and later took part in the surveys and construction of the Philadelphia and Wilmington Railroad.

Upon completion of this road, wishing to become grounded in the scientific part of engineering, he became a student in the Rensselaer Polytechnic Institute, at Troy, New York, whence he graduated, in 1839, as Civil Engineer, taking the highest honor.

Soon after this Mr. Kneass was made assistant engineer and topographer on the State survey for a railway between Harrisburg and Pittsburgh; he then became draughtsman in the Naval Bureau of Engineering at Washington, and was afterward employed by the British Commission in preparing the maps of the northern boundary, between the United States and the Provinces; and subsequently, by the Federal Government on the general map of the boundary survey.

At a later date, 1869, he was appointed, jointly with Colonel James Worrall, a commissioner to settle the boundary between Pennsylvania and Delaware. The location of this line permanently and correctly (an arc of a circle of about twelve miles radius) required great care, for the accomplishment of which Mr. Kneass's remarkable thoroughness peculiarly fitted him. The proposed line was not accepted by the Delaware commission.

In 1847, Mr. J. Edgar Thomson, Chief Engineer, selected Mr. Kneass as one of his assistants in conducting the preliminary surveys, which resulted in the construction of the Pennsylvania Railroad. He was soon promoted to the position of Principal Assistant Engineer, and engaged in the construction of that part of the road from "Jack's Narrows" to Tyrone, including nine bridges and Tussy Mountain tunnel.

Under his supervision, and from his designs, the first shops and engine house at Altoona was erected.

The construction of the road from Altoona to the summit of the Alleghenies was a work of much difficulty, and called forth engineering ability of a very superior order, in the accomplishment of which Mr. Kneass proved himself fully capable. We must remember that at that time none but hand-drills were used in rock excavation and tunneling, and no high explosives or steam excavators employed.

In 1853, he resigned to accept the position of associate engineer with Mr. Edward Miller, Chief Engineer of the North Pennsylvania Railroad, in which capacity he remained two years, leaving to accept the office of Chief Engineer and Surveyor of the consolidated City of Philadelphia, to which position he was elected by Select and Common Councils, March 29, 1855, and subsequently re-elected three times, namely, April 12, 1860; April 12, 1865, and April 14, 1870, each for a term of five years.

Mr. Kneass's services in the Department of Surveys were of great value. The City proper and the seven adjoining Districts were, up to 1855, ea-

tirely distinct and separate corporations, each having its own boards, officers, surveyors and engineers, working without any concert of action, or connected fixed plans either of grades, standard of measures, or designs of sewerage. Even the records of the old Districts were deposited indiscriminately in a City warehouse, and had to be collected, arranged and classified.

It therefore became necessary to establish a general plan of grades, sewers, &c., &c., that would combine as far as possible the disjointed work previously done. To this task Mr. Kneass applied himself with all his energy, engineering knowledge, experience and capacity for classification.

Maps were made of the whole area of the consolidated City, from which the grades were adjusted, the drainage areas carefully computed, and a standard of size for sewers established, that was intended to be useful not only for the sewers built whilst he was in office, but which amply provided for the entire future drainage system of the City.

Up to 1865, there was no record or plan by which the ownership or dimensions of an individual property could be ascertained. Under an Act of Assembly, passed March, 1865, Mr. Kneass organized and put into successful operation, what is known as the Registry Bureau. By an exceedingly simple system of plans, and records, arranged in book form, the information in regard to any individual property can be obtained in a very few minutes. The record is of very great value and importance to the general public, and exceedingly useful in getting data for an equal assessment of taxes, to effect which object the Act of Assembly was mainly intended.

The method devised and employed has since been adopted by other cities, without any attempt to improve upon it.

During Mr. Kneass's term of office several very important bridges were required to be built across the Schuylkill at various points, the first and most important being at Chestnut street.

In 1857, Councils advertised for designs for a bridge at that street, and appointed a Commission, consisting of J. Edgar Thomson, Ashbel Welch, and John C. Cresson, to decide upon the merits of the designs, which were all presented anonymously, being simply distinguished by the private marks of the designers.

Mr. Kneass considered it his duty to present a plan, and did so in the manner described above. This plan was fully approved by the Commission, and recommended to Councils for adoption.

The design was for the cast iron-arch bridge, essentially as erected, except in respect to the width of roadway, and length of the approaches; in regard to which the suggestions, and first plans of the engineer and surveyor were not adopted by Councils, because of the increased expense, a matter much to be regretted, now that the traffic has increased so much beyond that anticipated by Councils, but foreseen by Mr. Kneass.

This is believed to have been the first cast-iron arch bridge constructed in this country.

The location of the bridge, and particularly its western abutment and approaches, presented some difficulties of construction, but were believed to have been fully guarded, and at the time considered by the board of commissioners and all connected with the work as ample to insure its permanency.

In 1866, a commission was appointed by an Act of Assembly to build a bridge across the Schuylkill at South street, under the general supervision of Mr. Kneass, as Chief Engineer and Surveyor. The plans received from a number of bridge builders were referred by the commission to Mr. Kneass, who reported upon their relative merits, and recommended that submitted by John W. Murphy, with certain important modifications; among them the substitution of iron girders and cast-iron piers for the stone and brick arches over the marsh on the west side of the river. These suggestions were at first fully approved by the commission, but by subsequent action his advice was neglected, and the erection of the brick arches which he had condemned, and which have since failed, show their error in not being guided by the Chief Engineer and Surveyor.

In April, 1869, under direction of Councils, plans of a bridge were called for at Powelton avenue, or Bridge street. Mr. Kneass recommended the site of the old wire suspension bridge at Callowhill street, and a double roadway truss bridge. The general plans for such a structure were approved October, 1868, but owing to the tardy action of Councils in authorizing a loan, and making the appropriation, the contracts for the bridge were not fully entered into, and the work commenced, until after he had resigned his position; but the original designs were fully carried out by his successor.

During the war, in 1862, in company with the late Colonel C. M. Eakin, he was engaged in making reconnoissance of the military approaches to the city, extending along the Susquehanna river, from Duncan's Island to Havre de Grace. The work in the field and accompanying maps were highly useful at the time of Lee's last raid into Pennsylvania. This report, with the maps, are now deposited in the office of the Department of Surveys.

Mr. Kneass built the first street passenger road (the Fifth and Sixth or Frankford and Southwark) put in operation in this city, and then devised and established the form of tram rail, now used on all similar roads in this country. He subsequently acted as chief engineer of a number of the passenger roads of the city.

In 1871, Mr. Kneass was selected as one of two engineers to make a survey, and report upon the best means of draining or culverting Jones Falls, Baltimore, Md.

During Mr. Kneass term of office he was officially one of the Board of Commissioners of Fairmount Park, and rendered essential service in that capacity; his knowledge of the ground covered by the Park and its surroundings being very useful.

April 12, 1872, Mr. Kneass resigned his position as Chief Engineer and

Surveyor to accept the post of assistant to President J. Edgar Thomson, of the Pennsylvania Railroad, and subsequently occupied the same position under Thomas A. Scott, and Mr. George B. Roberts, the present President. In connection with this office he served as President of the following companies, viz.:

Belvidere and Delaware Railroad Co.
Columbia and Port Deposit Railroad Co.
Freehold and Jamesburg Agricultural Railroad Co.
Lewisburg and Tyrone Railroad Co.
Mifflin and Centre County Railroad Co.
Philadelphia and Trenton Railroad Co.
Pomeroy and Newark Railroad Co.
Philadelphia and Long Branch Railroad Co.
River Front Railroad Co.
New Jersey Warehouse and Guarantee Co.
Cressons Springs Company.

He was also a Director in forty-four of the companies identified with the Pennsylvania Railroad.

Mr. Kneass was a member of the American Philosophical Society, the Franklin Institute, the Historical Society, the American Society of Civil Engineers, and the Engineers' Club of Philadelphia, of which Club he was President during the year 1881.

He was one of the early members of the Union League, of this city, and one of its Board of Directors from December, 1879, to December, 1883.

Mr. Kneass was married, in 1858, to Margaretta Sybilla, granddaughter of the Hon. George Bryan, of the Supreme Court of Pennsylvania.

Mr. Kneass was a sincere Christian, a member of the Seventh Presbyterian Church ; in 1856 was elected a member of its Board of Trustees ; acting as Secretary until 1872, when he became President. His principles of honor were of the highest character, always just and impartial ; as a public officer, most carefully guarding the interests of his employers, whilst at the same time he was mindful of the rights of employés. A warm and reliable friend, kind and generous, his sound judgment caused him to be looked up to by those requiring his advice. His manner was courteous to all, inspiring respect from those with whom he was associated.

Note on a possible Geographical Meaning for the Set Griffin. By J. P. Lesley.

(Read before the American Philosophical Society, Jan. 4th, 1884.)

This chimerical animal sits on his haunches, with ears and tail erect, his breast and fore legs being vertical : his back slopes at 45°, and the end of his vertical straight tail is on a level with his head, so that the whole figure resembles a capital Roman letter N.

There is nothing peculiar about the animal except his ears and tail. He is evidently a jackal, fox or dog. But his ears are very long, stiff and straight in the air, diverging; and his rod-like tail is *forked* at the end. He is usually called a *griffin;* by some a *giraffe.*

Set was the genius of destruction and mischief, in some radical way connected with the sea, and I believe was the demon of the Red sea. He was the demon of the desert also. The Red sea is the sea of the desert lying between the Lybian and Arabian deserts. Egyptologists are familiar with the varying history of the religious worship of this deity, its opposition to the systems of Nile worship and Osiris worship, and its later fusion with the Sutech-Baal worship of the Syrian immigrants.

I wish to point out a plausible geographical explanation of the original idea of Set, derived from the shape of his ideograph.

In hieroglyphic inscriptions running from left to right, the animal sits facing the west, his back slopes south-east, and his ears are often portrayed not only diverging but pointing a little forward, a little west of the vertical. I fancy that a representation of the Red sea, with its two gulfs of Suez and Akabah, was intended; and that its tail was meant to represent the Persian gulf, *forked* to represent the Euphrates and Tigris rivers.

A forked vertical tail to an animal so simply constructed in the ordinary shape of a jackal was certainly a most extraordinary freak of fancy, if there lay no hidden meaning behind the design. It cannot be objected that the old Egyptians were not good geographers. The orientation of the pyramids in the fourth dynasty, and the expedition of Hannu to Punt, in the 11th or first Theban dynasty, are in evidence to the contrary. But it is a question how early the Egyptians knew Mesopotamia or Chaldæ well enough to represent its two rivers (the rivals of their Nile) by the fork of a tail to their ocean deity, or otherwise. The god Set appears to have been worshiped by the mother of the builder of the first pyramid. The campaign of Kedarlaomer was a comparatively late event, probably subsequent to the 12th dynasty; but it suggests similar movements on a less heroic scale in much earlier days; and no one has yet made out the direction from which the pyramid builders came to take possession of Egypt. It is evident that they introduced a foreign Ra, and Hor worship; but whether they brought with them Hathor and Set, or found them in Egypt is not known.

I think the Ata-Teta-nomenclature of the very first dynasty is good evidence that the pre-pyramid rulers had come from Yemen; but the pyramid builders would more likely come in from Syria, and stop at Memphis. If so, they would undoubtedly be familiar to some extent with Mesopotamia, if only through wandering merchants, or, if there were none such, through that transmission of information from region to region which has characterized all ages.

Stated Meeting, April 18, 1884.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Mr. Vaux was introduced and took his seat.

Letters of acknowledgment were read from the Vienna Central Institute for Meteorology (113), Royal Danish Society (112), Yale College (114), Vassar Bros. Institute (114), Maryland Historical Society (114), and the Franklin Institute (duplicate numbers of their Journal).

Donations for the Library were received from the Egyptian Institute; the Geological Survey of India; the Imperial Botanical Garden, St. Petersburg; the Royal Academy, Bruxelles; R. Accademia dei Lincei, Archives of the Chamber of Deputies Rome, Society of Natural Sciences, at Pisa; Société de Géographie, Annales des Mines, and Revue Politique; Société de Géographie Commerciale; Journal of Forestry and London Nature, Robert Atkinson, LL.D., Dublin; Canadian Institute; Boston Society of Natural History; American Journal of Pharmacy, Engineers' Club, A. E. Foote, Persifor Frazer and Henry Phillips, Jr., Philadelphia; Johns Hopkins University; U. S. Naval Institute; U. S. Department of the Interior; Chicago Historical Society, American Antiquarian, and Williams Bros., of Chicago.

A letter from Mr. William Brooke Rawle, Secretary of the Historical Society of Pennsylvania, to the President of the American Philosophical Society, dated April 17, 1884, was read, explaining the delay in returning the Penn and Logan Correspondence MS., loaned to the Historical Society April [illegible], 1879, and requesting permission to keep them a short time longer for the copyist. On motion, the request was granted.

Mr. Phillips having prepared a Register of written communications printed in the Proceedings of the American Philosophical Society, Vols. I to XX, inclusive, it was, on motion, ordered to be printed.

"Photodynamic Notes, No. IX," was communicated by P. E. Chase.

Extracts from a report on the Hams Fork coals of Wyoming Territory, by P. W. Sheafer, were read by the Secretary.

Mr. Lesley exhibited a model of the Nittany valley and Bald Eagle mountain, east of Tyrone City, Pa., made by Mr. E. B. Harden, from his own surveys.

Also a model of the Jones' iron ore mine in Berks county, by J. H. and E. B. Harden, after their own surveys.

Dr. T. S. Hunt gave an account of his examination of this and other like iron ore mines in Pennsylvania, assigning them all to the horizon of Prof. H. D. Rogers' Primal slates, although they lie in immediate contact with the Triassic rocks.

Dr. Frazer described the ambiguity of data respecting their true horizon, with facts to prove that while some of the mines (as at Dillsburg in York county) penetrate the Trias, these may be merely the redeposited detritus of more extensive Primal Slate iron ores.

The President, to whom the resolution on a change in the Order of Business Rules had been referred, reported an emendation of it, which was laid on the table for consideration at the next meeting.

New members elected:—

Richard L. Ashhurst, of Philadelphia.
Samuel Dickinson, of Philadelphia.
Rev. Joseph F. Garrison, M.D., of Camden, N. J.
John R. Baker, of Philadelphia.
Prof. Edmund J. James, of the University of Pennsylvania
Wharton Barker, of Philadelphia.
James H. Hutchinson, M.D., of Philadelphia.
Francis Jordan, Jr., of Philadelphia.
Herbert Welsh, of Philadelphia.
Prof. Henry S. Frieze, of the University of Michigan.
Francis Wharton, LL.D., of Philadelphia.

The Course and Growth of the Fibro-Vascular Bundles in Palms. By John Casper Branner, B. S.

(Read before the American Philosophical Society, October 19, 1883.)

The classification of phænogamous plants as endogens and exogens was based upon the theory of the supposed course and development of the fibro-vascular bundles in the stem of the palm. That a question of so much importance botanically has received no more careful attention, is probably due to the fact that the original theory of endogenous growth was considered so simple, satisfactory, and self-evident from a transection of a palm trunk, that its very simplicity was an impediment to investigation.

Comparatively few botanists have given especial attention to the subject of the structure of the palm stem, and those who have done so, have encountered so many difficulties in obtaining proper material,* and in getting satisfactory results from material to be had, that our certain knowledge upon the origin and course of the fibro-vascular bundles is still confused, and the theories and explanations of growth unsatisfactory and even perplexing. The best observers failed to grasp the whole subject, while others have given us masses of useless, irrelevant, and erroneous matter with only here and there a useful fact. From such results it is so difficult to select that which is useful, that it is simpler to leave the whole to one side and do the work all over from the beginning.

The difficulty, almost impossibility, of tracing the course of the fibro-vascular bundles in the hard, complex palm stem, has added not a little to the uncertainty and doubt that every one has felt who has advanced a theory of growth, or tried to prove their direction by actual dissection.

The peculiar structure of the trunk of the palm was mentioned about 300 B. C., by Theophrastus in his Historia Plantarum, Bk. I., Chap. IX. In the sixteenth century, Rumphius, French Consul on the Dutch Island of Amboyna, called attention to the same point, and in the seventeenth century his observations were confirmed by those of P. Labat, in the West Indies, and also by those of Desfontaines, made in Tunis and Algiers.

As a botanical question it may be said to have been opened by Desfontaines, member of the French Academy of Sciences, who, while he propounded a theory, personally took very little part in the discussion he had raised.† A general statement of his theory given by Mirbel‡ is sufficient for present purposes. In the "Fragment d'un voyage dans les Régences de Tunis et d'Alger, fait de 1783 à 1786," p. 290, Desfontaines says: "La

* Mirbel went to Africa to study the structure of the date palm, but even there found it almost impossible to obtain a grown one, and was about to abandon his work when a gentleman gave him a specimen.

† His views were published in the "Mémoires de l'Institut National," Vol I., 1796, pp. 478-602.

‡ Comptes Rendus de l'Académie des Sciences, 1843, Vol. I., June 12.

moelle des Dattiers est placées dans l'interval des fibres qui vont toujours en se serrant du centre à la circonférence, en sens contraire des autres arbres, et elles ne sont pas placées par couches comme j'ai en mille fois l'occasion de l'observer sur des troncs coupées."

Although Desfontaines kept comparatively quiet upon the subject, pupils of his, and especially Daubenton, took up his theory, and did all in their power to give it general acceptance in the scientific world. We know how successful they were, for, in 1819, de Candolle published the classification in which all phænogamous plants were divided into endogens and exogens. This classification was based upon the theory of Desfontaines, and, after its publication, was accepted without question of importance up to 1824, when Hugo von Mohl published his "De Structura Palmarum." Previous to Von Mohl, however, Moldenhawer had denied the theory of Desfontaines. As stated by Mirbel,* this theory of Moldenhawer was, that the fibro vascular bundles in monocotyledons take the place of the woody layer in dicotyledons, and that the lignification begins at the centre, and gradually approaches the circumference. If Mirbel's be a true statement of Moldenhawer's theory, I see no reason for considering it of much importance, as it was only proposing to replace one error by another.

The next work upon palm structure is that of Hugo von Mohl, published in 1824, as an introduction to Dr. C. F. P. von Martius' "Genera et Species Palmarum."† Von Mohl's work was done so carefully and conscientiously that although his theories have been attacked, and more or less modified by Meneghini and Mirbel, they have been generally and justly accepted as the best, if not the true ones, up to the present time. And, however much one may disagree with Von Mohl's conclusions, he cannot help feeling that his work would have been more thorough and more satisfactory if he had had more extended opportunities for observation. He admits that he had only young specimens, and portions of full-grown palms to work upon,‡ and any one who has tried to investigate this subject, can appreciate the difficulty or impossibility of demonstrating anything satisfactorily in a short section of a mature trunk, and may well wonder that Von Mohl came so near the truth with such unsatisfactory material from which to gather his facts and draw his conclusions. Writers upon palm structure are continually referring to the difficulty of dissection and investigation, and in the literature of the subject we find them admitting their inability to make out certain points§ on account of the impossibility of following the bundles.

Next after Von Mohl came Meneghini in his "Recherche sulla Struttura," etc.,‖ published in 1836, and followed in 1843 by more recent observations, under the title of "Intorno alla Struttura," etc.¶

*Comptes Rendus de l'Acad. des Sci., 1843, Vol. I., p. 1216.
†See under Von Mohl in literature at end.
‡V. Ray Society, 1849, pp. 73-77.
§Ray Society, 1849, p. 85.
‖V. literature at end, under Meneghini.

In 1839 the French Academy of Sciences sent out one of its members, M. C. F. B. Mirbel, to Africa for the purpose of investigating the structure and manner of development of the date palm, and in 1843 the results ot Mirbel's work were given to the Academy.* The following year Mirbel contributed a paper on the structure of *Dracæna australis*, in which he also referred to the question of palm structure.† Contributions to the subject were made by Lestiboudois‡ in 1840, and by Unger§ in the same year.

In 1845 Dr. C. F. P. Von Martius gave a statement of his theories upon the subject.‖ Sachs, in his text-book¶ refers to Nägeli,** and Millardet** as authorities upon the direction of the fibro-vascular bundles, but there is nothing in his own explanations to lead one to suppose that these writers differed materially from Von Mohl.

These are the names of the principal contributors to the literature, and since Von Mohl published his appendix in reply to Mirbel and Meneghini in 1845, it will be seen that little or nothing has been done in the way of original investigation.††

I will now briefly restate the theories held by the principal investigators in regard to the more important characters of palm structure.

First, we have the theory of Desfontaines, Daubenton and de Candolle, which prevailed up to 1824, and which has scarcely yet been completely eradicated from text-books on botany.‡‡ This was the theory of endogenous or inward growth. It held that the inner fibro-vascular bundles in a palm trunk ran to the new fronds, and the outer ones to the old. This theory was probably largely due to the fact, that in a transection of a palm trunk the outer bundles are hard and bony, while the inner ones are tender, and generally of a lighter color. Considering the state of botanical knowledge at the time this theory originated, it was perhaps a natural conclusion to draw from so limited an investigation of the subject. A hemisection of a palm trunk, as they understood it, would be represented diagrammatically by fig. I., and a transection by fig. II. Fig. II. has the fibro-vascular bundles displayed just as we find them in fact, the softer and lighter-colored ones through the centre, and the hard bony ones next the periphery. This crowded condition of the outer bundles was supposed to be the result of the growth of the new bundles at the top of the trunk, which pressed

* Comptes Rendus de l'Acad., 1843, Vol. I., p. 1218.

† Comptes Rendus de l'Acad., 1844, Vol. II., p. 689.

‡ "Études sur l'Anatomie et le Physiologie des Végétaux."

§ "Ueber den Bau und das Wachstum des Dicotyledonstammes," 1840, p. 35.

‖ Comptes Rendus de l'Acad., 1845, Vol. I., p. 1033.

¶ Oxford ed., 1875, p. 552.

** V. literature at end.

†† Dr. Gray refers (Text-Book, 6th ed., 1879, p. 71, foot note) to a memoir of recent date by Guilland: "Recherches sur l'Anatomie Comparée et le Developpement des Tissus de la Tige dans les Monocotyledones." Ann. Sci. Nat., Ser. 6, V., 1-176, 1877. I have not seen this work.

‡‡ Dr. Gray says that the word "endogenous" is still retained for the purpose of indicating a peculiar stem structure.

them out, and packed them closely together. This was also supposed to account for the even size of palm trunks.

The theory of Von Mohl, based upon careful study, completely overthrew the theory of Desfontaines. His investigations showed too that the structure of the palm trunk was no such simple matter as had been supposed. The leading features of Von Mohl's theory are as follows: Dissecting out a fibro-vascular bundle from the base of a frond, it curves in to the centre of the stem, and downwards, and after a short course through the centre of the trunk gradually approaches the periphery, and then runs down into the base. Later Von Mohl modified this statement, recognizing the fact that his investigations had been made upon too young specimens, and that in a full grown stem the bundles did not reach the base.* He then concluded that their lower extremities ended blindly on the periphery, and that at their upper ends they grew into the phylophore.† He observed their difference of structure in different parts, their varying size, their hardening, coloring, the slight growth in size of the bundles blending, and, after it was called to his mind by Meneghini, recognized their spiral direction (though he attached no importance to it‡), and that the course of the fibro-vascular bundles was the same in all palms.

Meneghini laid stress upon the oblique course of the bundles, and explained it as a mechanical result of unequal growth of stem and frond scars. He supposed the trunk to outgrow the leaf so much that the base of the frond was thrown out of its former relation to the other fronds, and that the bundles were thus drawn to one side, causing this obliquity in their direction. The occurrence of fronds at the same angle to each other on the stem was accounted for in the following manner: In the apex, as he believed, the fronds were arranged in a helix, which, in the course of growth, became a spiral line upon the stem, the fronds all having been drawn aside equally. He also advanced a theory of the creation of the fibro-vascular bundles by currents of sap in the phylophore, and thought they were to "be regarded as descending from the nascent leaf in the centre of the bud." §

*Duchartre, in his "Éléments de Botanique," p. 179, gives Von Mohl's theory in its original form, and in a figure represents the fibro-vascular bundles as all running into the base.

† There has been no little misunderstanding of Von Mohl's theory and descriptions. Mirbel did not know whether he meant that the bundles grew downwards from the bases of the fronds (Comptes Rendus, 1843, p. 1218, *et seq.*). In stating Von Mohl's theory, he says that "selon M. Mohl, les filets * * * * * partent des feuilles," and a little further on he declares that he does not know what Von Mohl means by saying that "les filets partent des feuilles et descendent vers la base."

Duchartre in his "Éléments de Botanique," p. 177, in explaining Von Mohl's theory, says of a fibro-vascular bundle: "Il descend verticalement sur une certaine longueur."

‡ Duchartre has credited Von Mohl with the discovery of the spiral direction of the bundles ("Éléments de Botanique," p. 177), but Von Mohl confesses that he laid no stress upon it, leaving us to infer that he had observed it. Ray Society, 1849, p. 52, third line from bottom.

§ Ray Society, 1849, p. 90.

Mirbel stated that the fibro-vascular bundle originated in a utricle at the periphery of the phylophore, and grew upwards into it, whence it curved outwards and entered a frond base on the side opposite the one upon which it originated.* "Le plus grand nombre, si n'est pas la totalité, nait à la surface interne du phylophore * * * * une partie d'entre eux s'allongent et monte à peu de distance de cette surface, puis se courbe tout à coup vers la périphérie et va joindre la base des feuilles, qui elles rencontre *chemin faisant.*" He believed the number of bundles in a stem might increase indefinitely, and in this way he accounts for the spindle-shaped trunks of certain palms.

Gaudichaud's theory was, that the bundles all originated at the frond bases† in the phylophore, and grew downwards to the base, and out to the ends of the roots. Says M. Gaudichaud :‡ "M. Mirbel soutent que c'est de bas en haut qu'elle agit ; moi je prouve par des faits, par tous ceux que j'ai observés que c'est de haut en bas, des bourgeons aux racines * * * Ils marchent donc !"

At the close of the reading of his seventh and last paper on this subject before the French Academy, he says, that whatever the Academy may think about the matter "Il ne me restera plus qu'à m'écrire, moi aussi : Et pourtant ils descendent !"§

Dr. Von Martius stated,‖ that all fibro-vascular bundles connected with fronds ; that they originated in the phylophore, exterior to and below the others ; that the points of origin were organic ; and that they grew upwards and downwards. He believed the bundles to end blindly below in the periphery, and that they might come to the surface above, either on the same side of the stem, or on the side opposite.

It is not my purpose to offer just here the objections that might be raised to the theories of these different authorities, but to present the result of my own observations in order, and to point out wherein they differ materially from those of others.

A transection of a full-grown palm trunk shows a number of hard fibro-vascular bundles scattered through it, without any further arrangement than that they are more numerous, harder, and generally colored near the circumference, while the parenchymous or pithy part prevails in the centre. A hemisection from base to apex shows (Figs. III, IV,) that the bundles have, for the most part, the appearance of being parallel, while at short intervals a few of them are seen to curve out from the centre of the stem to the fronds, or to the spadices growing in the axes of the fronds, or in case both spadices and fronds have fallen, to their old scars.

In trying to trace any one of these bundles, we find that it, sooner or

* Comptes Rendus de l'Acad., 1844, Vol. II., p. 690.
† Comptes Rendus de l'Acad., 1845, Vol. II., p. 264.
‡ Loc. cit.
§ Loc. cit., p. 272.
‖ Comptes Rendus de l'Acad., 1845, Vol. II., p. 1038.

later, becomes entangled in the mass, or that it has been cut across in making the section. With a hard stem this is invariably the result, but if the stem be a decayed one, in which the cellular tissue has disintegrated and left the bundles more or less free, the direction of a bundle may be followed with more or less certainty. Beginning with one of these where it curves inward and downward from the base of a frond, it may be traced inward to or near the centre, then downward, gradually approaching the circumference again. In this lower part of the bundle, however, the angle of divergence from a parallel with axis and periphery is so small in most palms, and the little curves made by the bundle in crossing others so misleading and confusing, that it is with some difficulty one can appreciate the fact that the bundles are not all parallel to each other and to the axis of the stem. If, however, the internodes are short, and the trunk is comparatively large, we may expect to find this angle more defined. This is very marked in the rhizomes of the so called trunkless palms* upon which the fronds are crowded in the shortest possible length of trunk. In these rhizomes this direction of the lower extremity of a division of a fibro-vascular bundle is visible at a glance. On approaching the periphery of the trunk the bundle is found to decrease in size, and finally it breaks off and appears to end blindly in the mass of other bundles near the surface. As far as can be made out then, in a full grown stem, by this method of dissection, this is what we find the course of the fibro-vascular bundles to be: from the base of the frond they curve sharply inwards to the centre, and then gradually outward to the surface, and there end. If it were possible to take up the bundles in any part of a stem, and follow them *upwards*, one after another, it would be found that they all connect, sooner or later, with fronds or spadices† (or their scars), and that none of them end blindly on the internodes.‡

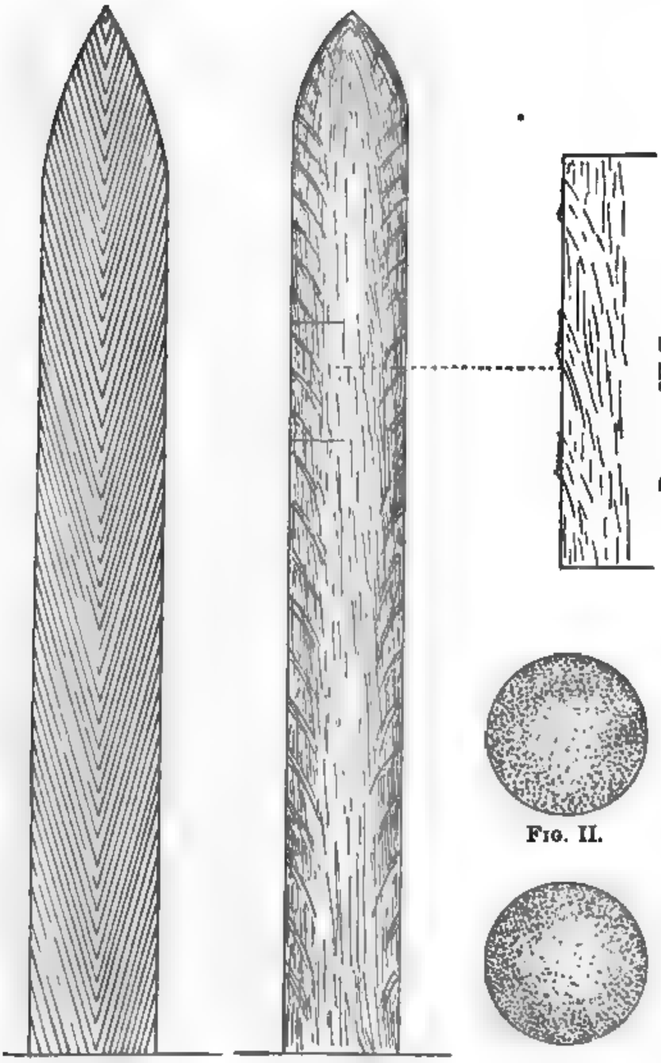
So far I have spoken of tracing a bundle downward from the insertion of the frond. To this method of dissection is largely due the uncertainty about the lower extremity of a division. By examining the apex, or growing part of the trunk, it may be seen that these bundles do not end blindly at their lower extremities upon the surface of the stem, but that they are connected in sections or divisions§ from the base to the apex, one with another, and one on top of another.

* In classifying palm stems according to their structure, Von Mohl made a sub-division of the rhizomes of trunkless palms, but made no investigation of them on account of lack of material. V. Ray Soc., 1849, pp. 6–7.

† Dr. Von Martius does not mention bundles connecting with spadices.

‡ In his "Text-book on Botany" (Ed. of 1879), Dr. Gray gives a figure of a palm trunk which represents the fibro-vascular bundles coming to the surface very much at random, and bending outward all through the stem. This is not what is seen in a palm stem, especially if the internodes are of any considerable length, but the bundles turn out to the fronds or scars *only*, and never to internodes.

§ I have spoken of the parts of a bundle between the points of branching as *divisions*.



PART OF III ENLARGED.

FIG. II.

FIG. I. FIG. III. FIG. IV.

I will first show how these divisions came about, and then show how this effects the whole system of structure. From the points of connection with the fronds or spadices, the fibro-vascular bundles branch, one part having the immediate external growth (either frond or spadix), developed in connection with it, and the other continuing to form part of the stem proper above this point.* It will be seen later that these divisions of the bundles reach their greatest developement within the stem just at this point of branching. Whether it is on this account, or for some other reason, whenever a bundle has a frond developed in connection with it the development of the stem branch is retarded. The attenuation of the lower extremity of a division, consequent upon this retarded development, renders it impossible, in most cases, to trace out the connection between the divisions, however carefully one may work. The elimination of the harder part of the bundle renders the observation of the connection still more difficult and uncertain.† In cases where this connection has been observed, it has been mistaken for blending, ‡ which often occurs, but which is quite another matter. Blending may take place in any part of a bundle's course, and may be in almost any direction, while the branching I here refer to, always takes place somewhere between the point where the bundle is tangent to a line parallel with the axis of the stem, and the point of insertion of the frond, and is always in the direction of the apex of the trunk. Blending may be upwards or downwards or sidewise, and may take place in any part of the whole length of the stem. It is often observable that just above the point of branching another bundle is developed on the inner side of the main division, but this piece is not continued as a distinct bundle, but as a part of the principal one.

Beginning then at the base of a palm trunk, a bundle is traceable into a frond, at the base of which it branches ; the stem division gradually approaches the centre of the stem, and there curves sharply outward to connect with another frond, and so, curving in and out, it connects with frond scars and spadices from base to apex.

Let us now consider these two directions of the fibro-vascular bundles: the gradual approach toward the centre of the trunk above the point of branching, and the comparatively sharp curve outward to connect with the external growth.

Why does a bundle always return to the centre of the stem, instead of going in a straight line from one scar to another?

First: the development of a fibro-vascular bundle is always in the

*The connection between the divisions is seldom easily found, some specimens show it much more plainly than others. The specimens in which I have seen it most often and most distinctly were of *Raphia tædigera*.

†Von Mohl admits his inability to determine how these small bundles end below. Ray Society, 1849, p. 69.

Duchartre ("Éléments de Botanique," p. 179) says: "Il se réduit à l'état de filament délié à son extremité inferieure."

‡Blending is mentioned by Lestiboudois (V. Literature at end), by Unger, and by Von Mohl. Ray Society, 1849, p. 8.

direction of the apex of the phylophore. When in the process of development, a bundle has a frond or spadix formed in connection with it, it is clear that the base of this frond, being left behind by the growth of stem and bundle, must at some time become a scar upon the side of the stem, and as the developing point of the bundle is always near the apex, the bundle will be formed more or less in a line connecting the scar or point of branching and the apex of the phylophore which is in the axis of the stem. But although the bundle is formed in this line, it does not follow that on the growth of the trunk it will be found in a straight line from the scar to the apex. In reality we find the lower extremity of the division as nearly as may be parallel to, and very near the side of the stem. This will be better understood from figs. V, VI and VII.

Let C be the apex of the phylophore at which a bundle branches. In the process of growth of the phylophore, the point C will be left behind at D, and the growing division of the bundle, pointing always toward the centre, will be developed in the direction DC or JI, practically very nearly parallel with the side CHD. Now when the apex is far beyond the original point of branching of this bundle, say at A, while the original point of C is at B, this part of the bundle that was formed first after the branching took place, will still have its original relation to the side of the stem, that is, it will be about parallel to it. When the point C is left at E, the direction will be still further changed, and will be IK, farther from the periphery, and when IK is left far behind it will be in a position like MN in figure V. Then again when the point C is left at B (Fig. V) we shall have the part IL forming, and thus will the growth of the bundle in length gradually approach it to the axis of the stem. Upon its arrival at a sufficiently advanced stage of development to take its place again, and again have a frond developed in connection with it, it will have crossed in its course all the bundles that have branched since it branched at C originally. I would suggest that this development of the fibro-vascular bundles, always in the direction of the apex, is due to the light. This apex, at its central point, is very pulpy and translucent, while its sides are enveloped by the young and growing fronds, which render the parts surrounding the centre more or less opaque.

The outward curve of these bundles is a simple matter. It marks the line traversed by the base of the frond from the time it originated at the apex of the phylophore until it reached its place on the side of the trunk. In figure VIII, let C be the centre of the growing part at which the frond and bundle connect. Now when the apex has grown to C′, the point C will have been left behind at A upon the side of the growing cone, and when the apex is at C′′′′, the point which was originally at C will have taken its place at E upon the side of the stem. In this outward curve, the longitudinal growth of the bundle is shown. In figure IX if C be the former position of the apex at which a frond was developed, and which takes its place later upon the surface of the stem at D, it might be inferred that CF were the vertical distance grown by this section of the stem from

the time the frond originated at C until it reached D. But such is not the case, for some allowance must be made for the increase of altitude caused by the side CG becoming parallel with the lower part of the stem. Taking GC as a radius and describing CI, the distance IE must be deducted as this difference in altitude of the point C when it reaches I, and the length grown by the whole section is FL or DI. It is true that when C reaches D, CF will be the difference in altitude made by C, but this is not all due to the growth in the length of the fibro-vascular bundles. In actual hemisections of palm stems it is noticeable that the curve CD is not an even one, but has a shorter radius near the point D. This is due to the fact that during the younger stages growth was principally in length, while as the part approached maturity, the lengthening was less marked, and the lateral growth predominated. This growing in size after prolongation has ceased is a characteristic of the fibro-vascular bundles in the palms. In the phylophore, the lengthening of the bundles is still possible to a limited extent, but it will be shown later that the growth in size continues even below the phylophore. It will also be seen later that this increase in the size of the bundles, and consequently in that of the whole stem after longitudinal growth has ceased, causes the fronds to droop more.

It has already been observed that the fronds are developed in connection with the *central* bundles in the phylophore. In regard to the origin of the bundles it is sufficient at present to say that they originate at the apex of the phylophore, and are developed in it, with it, and as a part of it. Von Mohl and Mirbel maintain that these bundles grow up into the phylophore; Gaudichaud that they grow downwards from it—from the frond bases; Von Martius that they grow both up and down, while I maintain that they are perfected in all directions at the same time, though the lateral growth continues to a certain extent after the longitudinal growth has ceased, and that they can no more be said to grow upwards or downwards than can it be said of the bones of the body that they grow outwards into the limbs. It is true that the general lengthening of the bundles takes place at the superior end, but there is a growth beside this. At the first appearance of the fronds at the apex of the phylophore the fibro-vascular bundles are already connected with them, and just as intimately as they are in the perfectly developed frond. The internodes at this point are very short, but the bundles are the same in number, and have exactly the same connections, directions, and relations to each other that they have in later life. But in the perfected frond we find them larger, longer and harder, and in the perfect stem the internodes are longer, the stem and bundles larger, while the whole plant has grown both longitudinally and laterally. In view of this general growth, the relations of the parts remaining the same, it is clear that growth does take place in all directions. In figure IX, p. 471, the upward and downward growth of a bundle is represented approximately by the line CD. This line cannot be upward growth alone, for the point D was once at C,

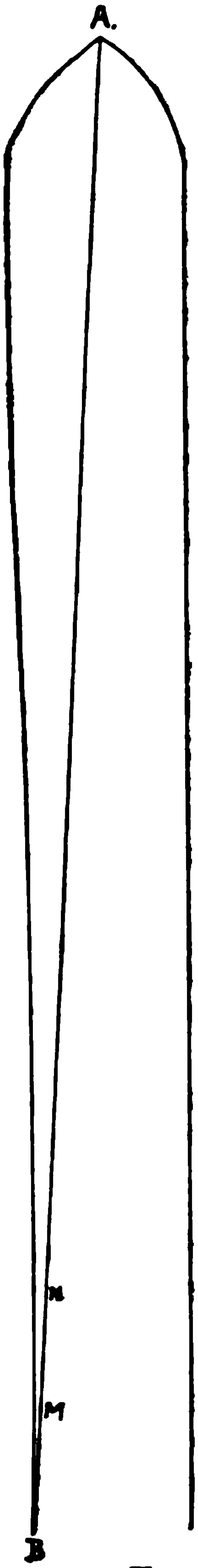


Fig. V.

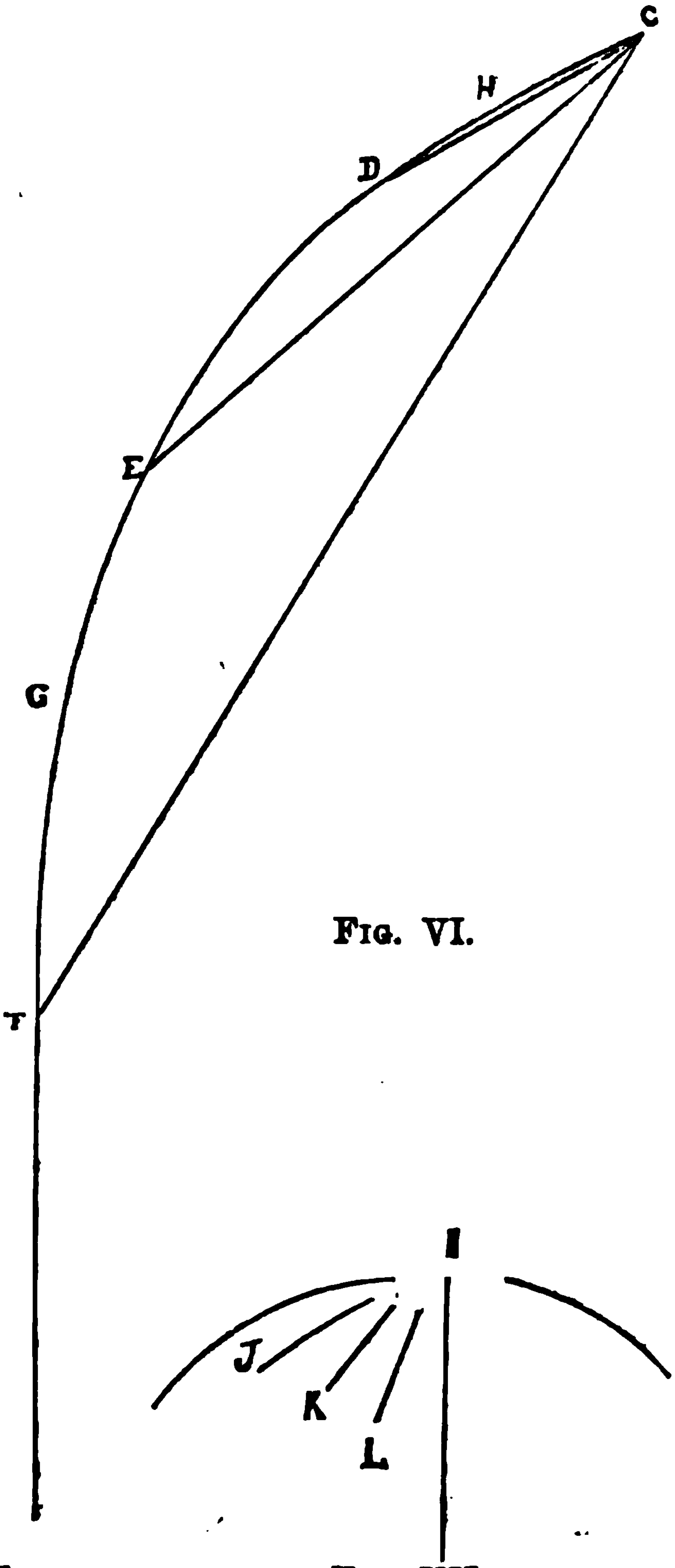


Fig. VI.

Fig. VII.

and when there, was a point on the surface of the phylophore. Now it has become a point on the surface of the trunk, the distance CD beyond its original position. so that the whole bundle must have grown in this part.

The theory of downward growth from the frond to the base, as held by M. Charles Gaudichaud, appears to me, as it did to Von Mohl,* unworthy of serious consideration. Mirbel's theory of upward growth of the fibro-vascular bundles was denounced by M. Gaudichaud as a physiological impossibility ; and it might be said of M. Gaudichaud's theory, that downward growth, as held by him, is a mechanical impossibility. From the course of the bundles, as already explained, it is seen that to grow downward, they would have to pass through the bony outer layer of the trunk twice : once on entering it, and again on approaching the surface lower down. Moreover the bundles at the base of the trunk would either have to be extremely small, or the base itself very large, neither of which is the case. It will be seen later, also, that the lower extremity of a bundle division hardens first, thus precluding all possible growth.

The reason that the fronds are always developed in connection with the central bundles, is because the central bundles are the ones there present, and the ones in the most advanced stage of development. It has already been noticed that when a frond is developed and a bundle branches, the part in connection with the frond is developed rapidly and at the expense of the part leading upwards. Having its development thus retarded, and being carried to one side by the growth of the trunk, this ascending division is attenuated at its lower extremity. Other bundles gain upon it in point of development, and take its place at the centre of the growing part. But in the course of time this division regains its vigor, and its place at the centre of the phylophore, where it is again the most advanced in development, and again has a frond or spadix formed in connection with its branches, and is again curved outward.

At the time of branching the formation of the frond is the immediate object of the bundle, but provision is at the same time made for other fronds higher up.

The branching goes on from the base of the trunk to its apex, varying only as the tree becomes old, and its vital powers diminish, the result of which is shorter internodes, and consequently shorter divisions of the fibro-vascular bundles.

The number of bundles may be said to be the same in all parts of the stem, and it is to this fact, taken in connection with the average even size of the bundles themselves, that the equal size of the palm trunk must be attributed. In specimens of which I have estimated the number of bundles at different altitudes, there has generally been a difference in favor of the base of the stem, but this difference is so slight that I believe the decreased vitality of the plant is sufficient to account for it. It is also

* Ray Society, 1849, p. 52.

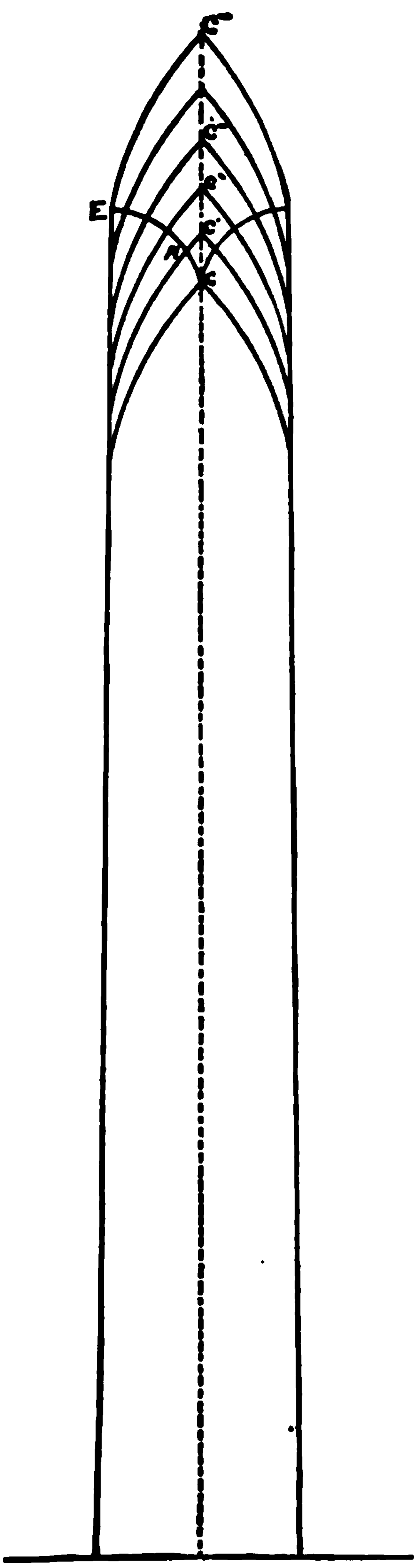


Fig. VIII.

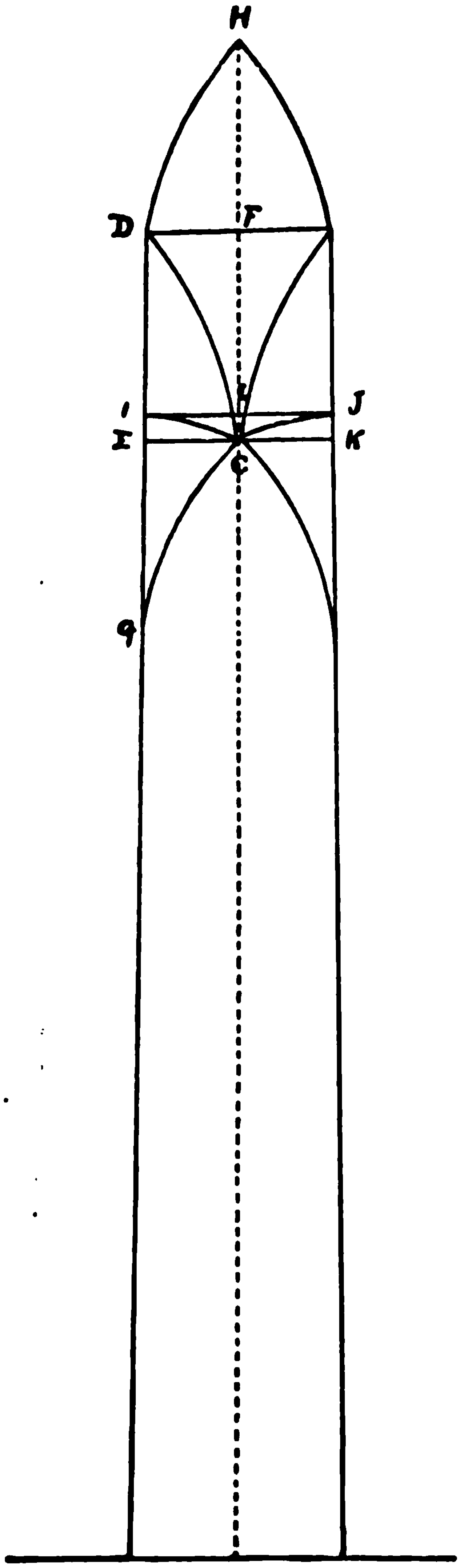


Fig. IX.

possible that the same number of bundles was present in the upper sections as in the lower ones, but that being smaller, they escaped my attention. In this connection I will refer to Mirbel's explanation of the spindle-shape of the stems of *Iriartea ventricosa* and *Acrocomia lasiopatha*. Referring to Von Mohl's theory, as originally stated, that all bundles ended in the base, M. Mirbel said :* "Il est un fait dont sans doute M. Mohl a connaisance, c'est qu'il existe des Palmiers pourvus d'un stipe mince à la base, mince au sommet et notablement renflée dans sa partie moyenne. Ce stipe resemble donc a une enorme fuseau * * * * * Je demande a M. Mohl comment il explique cette anomalie en restant fidèle a son hypothèse. Pour moi, rien de plus simple depuis que j'ai reconnu dans le Dattier que les filets naissent de bas en haut, de tout le pourtour interne du stipe, et à toutes les hauteurs. A la naissance de l'arbre fusiforme, la végétation est faible, les filets sont peu nombreux, et par consequent la stipe est grêle. A mesure que l'arbre s'éleve, la végétation devient de plus en plus active, le nombre des filets augmente sensiblement, le stipe grossit. Mais quand l'arbre a atteint une certaine épaissure la végétation s'affaiblit, le nombre des filets diminue, le stipe va s'amincissant jusqu'au sommet."

Had M. Mirbel ever examined the trunk of one of these fusiform palms, or had he even read a description of their method of growth, he never would have tried to explain this increase in size in this manner.

I am not able to give at present the physiological reason for this peculiar growth, but I am able to give some explanation of how it occurs. In transections these palm stems show the same number of bundles in the swollen part as in the more slender parts both above and below it. When there is a difference, it is such as may be found in any palm having a cylindrical trunk. In the swollen part there is a great increase of cellular tissue, and a very slight increase in the size of a few of the fibro-vascular bundles. M. Mirbel represents this enlarging as taking place during the growth of the tree, and at the top, whereas it does not occur until the palm has attained almost its full growth. The *young Iriartea ventricosa* never shows this enlargement in any part of its stem, and when it does occur in the grown plant, it is at a considerable distance below the growing part.† In some species of *Acrocomia* the swelling takes place near the summit, but always after the crown of leaves or phylophore has passed the part. In one species examined at Asuncion, in Paraguay, the trunk has no certain point at which it swells, but may swell out either at the base or the summit, or anywhere between the two parts, and there are many cases in which there are swellings both at the base and just below the fronds. Neither is the tapering of a few palms like *Oreodoxa oleracea* and *Euterpe oleracea* to be explained by a decrease of the number of fibro-vascular bundles toward the top. In examining many trunks of *Euterpe*, I found the number of bundles near the base and near the top about the

* Comptes Rendus de l'Acad, 1843, II, p. 1123.

† Wallace's "Palms of the Amazon," p. 37.

ut I always found, where there was a decided tapering of the trunk
se to summit, that there was a difference in the size of the bundles,
be sure, but quite as marked as the difference in size of the two
' the trunk. This difference in the size both of the trunk and of
idles is more noticeable in *Oreodoxa oleracea*, or the royal palm,
any other palm which came under my observation.

e spoken of the branching of the fibro-vascular bundles and their
ilways to a frond base, as if their course was on the same side of
ik and in a vertical line. Neither is the case. It often happens
tead of returning to a frond base upon its own side, the bundle
through the whole stem and connects with one on the side oppo-
Mirbel claimed that in the date palm, the bundles all crossed from
to the other. I shall not say this is not true of the date palm,
well aware that there is a great variation of structure among
but I have never found this crossing from side to side to be the
though it often occurs, and is more marked in some palms than in

dition to this occasional crossing the stem, the bundles have a
direction, so that their course is not directly vertical, but spiral,
ght and left, about the stem, part of them going to one side and
the other. From base to summit then, a bundle may be said to
spiral plane within which it grows, and whether it returns to the
upon the side on which it originated or upon the opposite side, it
rs in this spiral plane. Meneghini tried to explain this spiral direc-
the bundles as a mechanical result of the growth of the tree where-
relative sizes of the trunk and frond bases became changed. He
d the fronds upon the apex to be arranged in a helix, and that as
grew this helix developed into a spiral line upon the stem. He
l the leaf bases to be always of the same size, both upon the grow-
e and upon the stem. The growth of the trunk then, and the un-
l size of the bases of the fronds necessitated a drawing of the
toward these bases, which resulted in the spiral direction.

have observed that the relative position of the fronds is always
e, a matter which Von Mohl was in doubt about. The spiral
n of the bundles is in no way a mechanical one, but exists alike in
d phylophore as I have often observed, and until some better
can be assigned for it, must be considered as organic.

existence of a palm having its fronds arranged in one plane† would
f be sufficient to upset Meneghini's theory of the helix and spiral.
iral direction of the fibro-vascular bundles is an important one,

'on Martius believed this to be the case, as will be seen in the Comptes
de l'Acad., 1845, Vol. I, p. 1038.

it Pará and the mouth of the Amazon a distichous palm is very com-
t is popularly known as the *baccába*, and is the *Œnocarpus baccaba*
ius. *Urania speciosa* and *U. amazonica* are other distichous monocot-

both in connection with the structure of the plant, and in its influen upon the plant's general appearance.* It varies greatly in different speci and may be almost wanting. In trying to split palm stems, those which the spiral direction is less marked, split more readily than those which it is more decided. It is not very marked in *Mauritia caraná*, *Euter* and *Iriartea*, while in *Maximiliana* and *Manicaria* it is a very promine feature.

It is not in the trunk alone that spiral direction is to be seen, but it more or less observable in the fronds and spathes. The trunk may hav a very decided spiral direction in its fibro-vascular bundles, which may b wanting in the fronds, and *vice versâ*. *Raphia tædigera* (vulg. *Jupatý* for example, has a marked spiral direction of its bundles in the trunk while the petioles of the fronds split with almost perfect evenness. Spir direction in spathes is well shown in the spathe of *Manicaria saccifer* (vulg. *Ubussú*), which resembles coarse cloth somewhat.

In the petioles and midribs of some palms, modifications of spiral direc tion give rise to peculiar and characteristic forms of midribs, resulting in changes of the leaf planes from a horizontal to a vertical position, which are characteristic of the species in which they occur.

It has been noticed by those who have studied and observed palms in their native forests, that, after a certain amount of experience in familiari zing one's self with the general appearace of them, the common palms can be distinguished at almost any distance at which they are visible, if only the fronds can be seen. In those having pinnate fronds this is very largely due to the effects produced by changes in the leaf planes, which are the result of changes in the shapes of the midribs, which, in their turn are the result of the direction of the fibro-vascular bundles. In the *Maximiliana regia* Mart. (vulg. *Inajá*) and *Attalea excelsa* (vulg. *Urucurý*) of the Amazon region, and in *Acurý* † of the upper Paraguay, the bundles in the midrib are turned to one side as shown in figure X, page 477.

In No. 1 is shown a section across a midrib not far from the trunk, where it has the usual shape of a midrib. In No. 2, a section further outward, the bundles of the side CB (1) have moved up and gone to form an extension of AB, while a corresponding number from the side AC have taken their places on CB. The result is a figure like No. 2. No. 3 represents a section still further out, and No. 4 is one near the tip, this direction to one side being more marked the nearer we approach the end of the frond. The midrib assuming these forms, it is impossible for the frond to maintain its horizontal position, whereupon it changes its leaf plane from a horizontal to a vertical position, and droops over on its edge. It might be supposed that this twisting of the frond is due to some arrangement of the leaflets with reference to the light, but in the *Maximiliana regia* (*Inajá*) the tips of the fronds are completely inverted in a great many

* I have not studied the relation of the spiral direction of these bundles to the phylotaxis, but I suggest that the two are related.

† Botanical name not known.

cases, if not always, so that what was originally the lower side of the frond is turned upwards.

In a number of transections of a large, living and nearly grown palm stem, in those made near the base, it is found that the fibro-vascular bundles are all black, if black be the characteristic color of the mature bundles,* except a few in the centre. A section made anywhere below a certain distance from the fronds would show the same general character as regards hardness and color. But on coming near the growing part the sections appear less and less colored, and above the fully-matured fronds they are all found to be colorless. Dissecting out these bundles in the phylophore we find that those already colored, or nearly so, connect with the lower or more mature fronds, while those connecting with the younger fronds are, for the most part, colorless; and, when showing any color at all, it is only at the lower extremity of the division. We find, then, that there are uncolored bundles near the base of the trunk at the centre, and also all through the section near the top. I therefore place these facts against the theory of Mirbel, that the color of the bundles is due to age alone,† and also against that of Von Mohl, which is that color is due to position alone. In regard to this coloring, the element of age is a necessary one when the division is considered longitudinally, for in this case the bundle is colored for a short distance at the upper end where it passes in to the centre, then follows a part in which it is comparatively uncolored, while the remainder, and larger part, is colored. But in considering a transection of a trunk with reference to the coloring of the bundles, position is the necessary element. This is because the lower extremities of the divisions begin to color and harden before any other parts, and, as has already been explained, these lower extremities lie next the surface of the stem.‡

Thec omplete hardening and coloring of the fibro-vascular bundle divisions does not take place until the frond or spadix, with which they are connected at their upper extremities, have fallen or died. As has already been mentioned, the bundle divisions begin to harden and color at their lower extremities before the frond or spadix dies, but not before it is unfolded and active. At the fall or death§ of the frond the hardening and coloring are complete, and this marks the limit of growth of the division bundles originally connected with it. As far as these hard, colored bundles

* Some palms have the mature fibro-vascular bundles of a waxy color, such as *Oreodoxa*, *Euterpe* and *Geonoma;* others have them of a deep, reddish-black, like *Mauritia;* while the majority of them are black. Examples: *Acrocomia*, *Guilielma*, *Astrocaryum*, *Bactris*, etc., etc.

† Ray Society, 1849, p. 82.

‡ The edible part of the "palmito" of Brazil and of the "cabbage palm" of the West Indies, is the long phylophore in which all the fibro-vascular bundles are soft and colorless.

§ I mention the falling *or* death of the frond because in some palms the fronds fall as soon as they die, while in others they cling to the trunk for a long time after death. Ex.: *Acrocomia lasiospatha*.

are concerned, the growth of the whole stem is at an end. In fact, however, the stem does continue to grow to a certain distance below the phylophore, but this growth is lateral and not longitudinal. A palm trunk* may grow laterally as long as the fibro-vascular bundle divisions of the given part are in connection with active fronds.* It is plain, then, that there can be no longitudinal growth below the lowest active fronds. But in regard to lateral growth, there is no practical line of demarkation between the full-grown and growing parts of a trunk, because full-grown and growing parts overlap each other. Theoretically the growth has ceased below the lower extremity of the bundle divisions connected with the lowest active fronds. Practically it varies much with the species, age, vitality and circumstances of the individual.

Being impossible below the fronds, longitudinal growth is necessarily confined to the phylophore or part above the lowest active frond. We may therefore naturally expect to find palms that have long phylophores attaining considerable heights, and having the internodes long. In almost all young palms, whatever the species, we find the phylophore very much longer than in full grown ones of the same kind, and the internodes longer in the same proportion. The young *Mauritia flexuosa* has its active fronds covering it down the trunk four or five times as far as an old individual of the same species, and the same is true of all the palms I can now call to mind. But this long phylophore gradually shortens with age, while the internodes shorten in the same proportion, and the fronds have a more decided drooping. In genus *Desmoncus* the trunk is covered with active fronds for a large part of its whole length, or, in other words, it is nearly all phylophore, and, as might be expected, we find it attaining enormous lengths,† with a very slender stem and long internodes, in comparison to its size. The length of the phylophore in this genus, as compared to its size, has caused it to assume the habit of a clambering or climbing palm. It reaches so great a length before any of its fronds cease to be active, that is, before any of its fibro-vascular bundles harden, that it is incapable of sustaining its own weight. If an *Assai* (*Euterpe oleracea*) palm retained its fronds active to the same length proportionally that *Desmoncus* does, it would grow to be about a hundred feet long before its fibro vascular bundles hardened near the base, and the result would be that it would fall over and become a clambering palm. The slender trunk alone of *Desmoncus* is not sufficient to account for its habit, for it falls over while it is still a mere shoot, not more than three or four feet in length. Then too there are many palms even more slender than *Desmoncus*, palms

* Sachs (Text-Book, p. 552), says that "each portion of the stem, when once formed, maintains the thickness which it had already attained within the bud near the apex of the stem." There may be some palms of which this is nearly true, but it is far from being true in all cases, while it leaves the swelling of spindle-shaped trunks as badly accounted for as do the explanations of M. Mirbel.

† I have seen this palm over thirty metres long with a stem but little more than one centimetre in diameter.

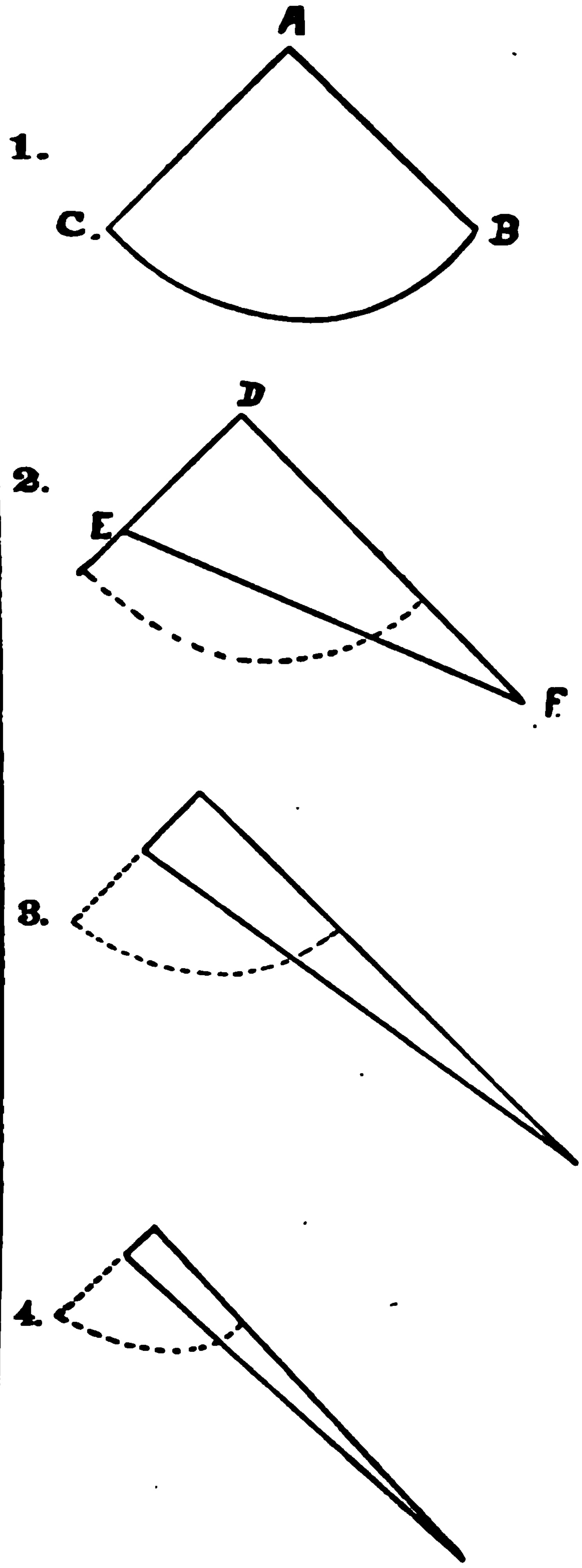


Fig. X.

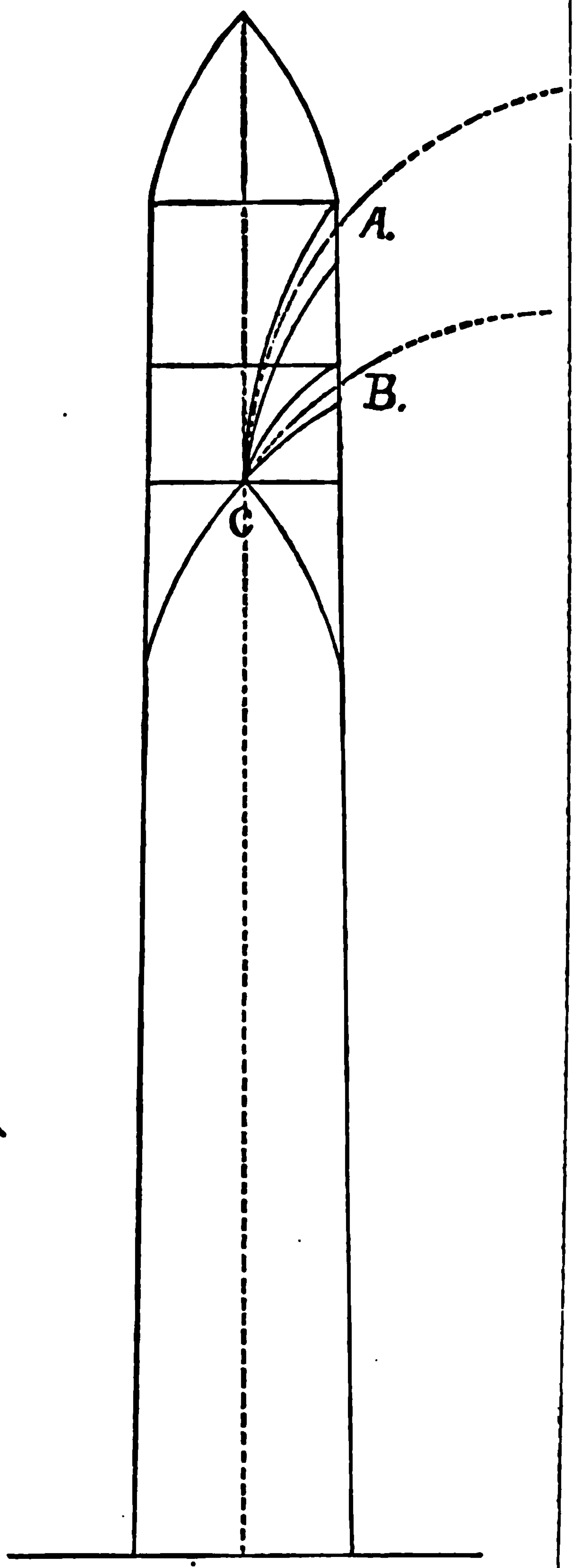


Fig. XI.

whose trunks are not larger than an ordinary lead pencil, but which, having the phylophore comparatively short, have the fibro-vascular bundles hardened early, and are consequently perfectly upright in habit.

I have not seen the Asiatic genus *Calimus* growing, nor have I been able to see any careful description of it, but judging from its slender stem and long internodes, I venture to guess that it has a very long phylophore, and to suggest that its great length and clambering habit is to be explained in this same manner.

Speaking of palms in general, in the same individual, the length of the internodes has much to do with giving it character as seen in its general appearance. As the length of the internodes, the age and vigor of the plant, and the drooping of the fronds are all intimately related, I will speak of these subjects in the same connection.

The drooping of fronds which is so much more marked in old palms than in young ones, in feeble than in vigorous ones of the same species, is caused :

First. By a decrease of the strength and vigor of the fibro-vascular bundles of the midrib. This variation in the strength of the midrib effects the drooping of the frond throughout its whole length.

Second. By the decrease of the vital powers of the whole plant, from which it results that the angle made by the outcurving bundles with the axis of the stem is larger than in the case of more vigorous growth.*

This effect can be seen by diagram, figure XI, in which C is the point of the phylophore where a frond is originated. In a case of feeble growth, the frond would stand out at B, making a large angle with the axis of the stem, while in case of vigorous growth, it would stand out at A, making a comparatively small angle with the axis. The result of difference in growth is very distinctly seen by comparing the young plants with old ones of the same species grown on the same soil. In the young ones the internodes are invariably† longer, and just as invariably the fronds are more erect. The fronds being continuations of the bundles, the angle made by the bundles with the side of the stem is continued into the fronds under slight modifications. The effect of this angle upon the fronds is also noticeable in the phylophore, for the angle at which the bundles cross the periphery being smaller in the cone-shaped apex, the fronds have a more nearly erect position. In figure XII, the upper fronds make a smaller

* Hence the angle of drooping in fronds, taken alone, is not always a specific characteristic, as stated by Wallace in his "Palms of the Amazon," p. 5.

† Peculiar circumstances may change this, as I once saw well illustrated in the case of a *Mauritia flexuosa* near Pará. The whole trunk was about thirty metres high, and about six metres below the fronds, the old scars were very close together, and the trunk had every appearance of having completed its growth at that point. Above this, however, the trunk appeared to have renewed its youth, and the internodes were long and smooth like those of a vigorous palm. In seeking the possible explanation of this new growth, I found that the place where the palm stood had, a great many years before, been a forest, and that it had originally stood in the edge of a stagnant pool which had been drained. Whether these were the causes of the renewed vitality there were no means of ascertaining, but the evidence of that vitality was unquestionable.

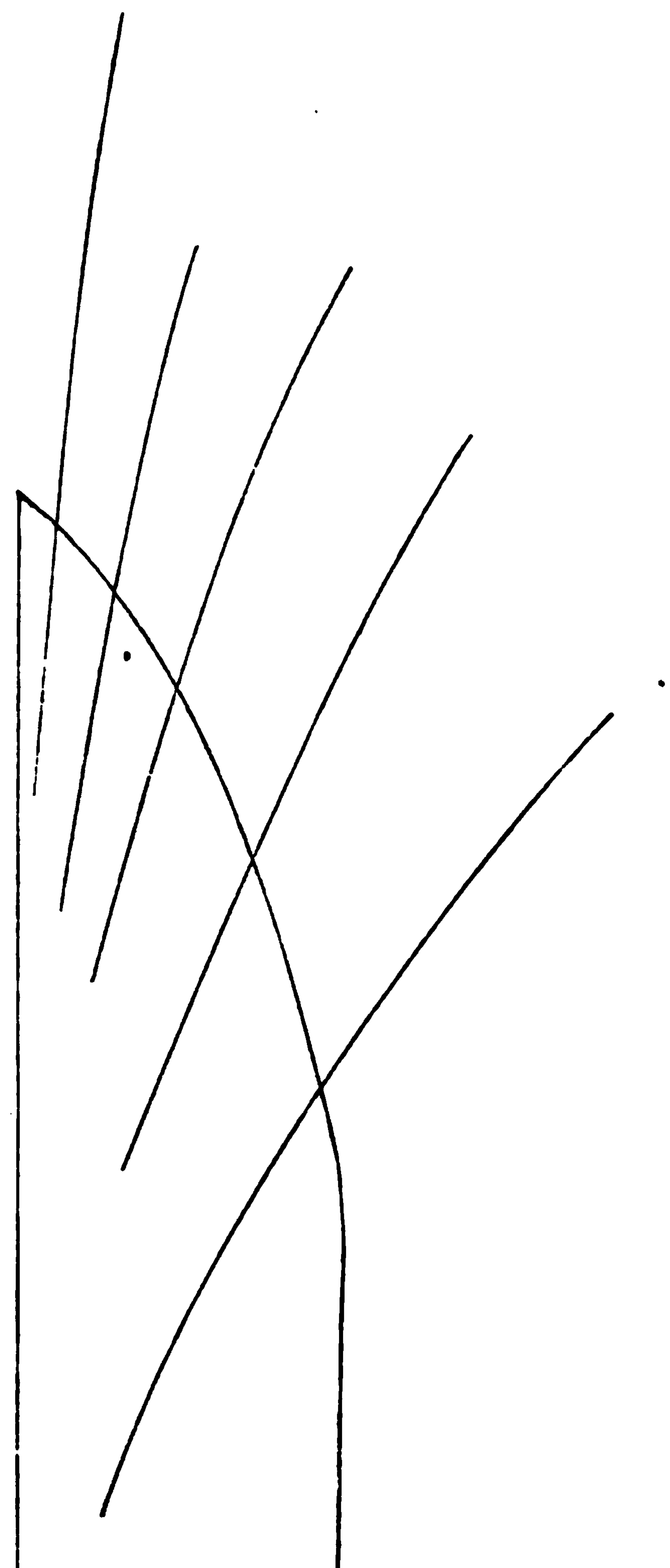


Fig. XII.

angle with the surface of the apex, and are more nearly erect. But when, in the course of time, the fronds which are now the highest, come to be the lowest, the angle they make with the periphery will have been much increased by the lateral growth of the trunk, which will bring the fronds out at shorter radii, and the result will be a more decided drooping of the lower fronds. In this arrangement upon the growing part is a provision for the weakness of the young fronds, which could not sustain their own weight if the angle made with the trunk were a larger one. I have already explained that the shorter radius at the surface, as seen in the lower fronds, is due to the lateral growth being greater than the longitudinal, and, of course, takes place as the fronds come to be the lowest in the crown.

I have also stated that in palms having perfectly cylindrical stems, the fibro-vascular bundles *average* the same size from the base to the upper end of the full grown part. They vary however in each division, reaching their greatest development within the trunk just where they curve outwards to connect with the external growth, and beyond this to a distance in the petiole varying with the length and weight of the normal frond. The variation in size appears to be due to the purpose which the bundle serves at the given part. In those palms which have long and heavy fronds, the bundles are greatly developed near the base, and in addition, they assume structural forms capable of adding to their strength in the manner needed by the tree, while in those having short and light fronds there is comparatively little development of the bundles at the bases of the petioles.* The frond of *Raphia tædigera* (*Jupatý*) is noted for its great length and weight.† In this palm the fibro-vascular bundles are cylindrical, or reach their greatest lateral development just at the juncture of the frond with the stem, and are flattened laterally in the base of the petiole, the upper edge being the thicker. This shape gives them about three times the strength they would have in the ordinary cylindrical shape, for supporting a weight applied as it is in this part of the petiole. There is another structural peculiarity about these bundles in *Raphia tædigera*, which I have not sufficiently investigated. When a frond dies, it breaks off just beyond the enlarged part of these bundles, and in time the broken petiole that remains fast to the trunk decays, leaving the larger fibro-vascular bundles exposed. In this condition, one might expect to find them bent downwards by the strain of great weight sustained by them from the beginning until they became rigid. But so far are they from being warped downwards, they ar not even straight, but bend back

* *Jupatý*, *patauá*, *murumurú*, *urucurý* and *uauassú* all have large fronds, and proportionately large fibro-vascular bundles in the bases of the petioles. *Assaí*, the *marajás*, the *paxiúbas* and *mucajás* have small fronds, and small bundles in the bases of their petioles.

† I have measured fronds of this palm that were fifteen metres long. Wallace says he has seen them fifty feet long. V. Wallace's "Palms of the Amazon," p. 43.

in exactly the opposite direction to that given them by the drooping of the frond.*

Gaudichaud maintained that the fibro-vescular bundles of the palm-trunk ran down into the roots. My own observations agree with those of Von Mohl, that there is no such direct connection between the bundles of the stem and those of the roots. Anyone acquainted with the habits of such a palm as *Iriartea exorrhiza* could never have conceived a theory so out of keeping with the facts of the case. This palm puts out new roots continually, as do almost all palms, and always above the older ones. If the bundles of the trunk ran directly into the roots, the same roots would have to serve the tree through its whole lifetime, for the number of bundles in the trunk does not increase. To be sure, Gaudichaud maintained that the bundles descended from the fronds to the roots, and granting his premises there might have appeared to be some reason in this conclusion. But the supposition that the bundles ran downwards necessitates, as a consequence, a base much larger than the upper part of the trunk, as well as a continually increasing one, or else very small bundles at the base. None of these things are found to be so, but it is found that the bundles of the trunk do not run into the roots.

Von Mohl considers the spines on the aërial roots of *Iriartea exorrhiza* to be aborted rootlets, and directly connected with the fibro-vascular bundles of the roots. I also found them to be aborted rootlets, but they are as independent of direct connection with the bundles of the roots proper, as are the roots themselves of the bundles of the trunk.

In conclusion I find : (1) that all fronds and spadices originate at the centre of the phylophore ; (2) that the fibro-vascular bundle division continues to grow until its frond reaches maturity ; (3) that the growth of a palm trunk continues as long as the bundle divisions of the part are in active connection with living fronds, and no longer ; and (4) that the growth of palms is therefore an internal growth, and the term endogen is not a misnomer as far as palms are concerned.

From another point of view I find, that the outward appearance of a palm, the form of its trunk, the plume-like drooping of its fronds, the motion given them by the wind, the breaking and twirling of its leaflets, and its general picturesque beauty are only the outward manifestations of the laws of its internal growth and structure.

* Another interesting point in regard to the bundles in the fronds is the direction in which they face. (For want of a better definition I have spoken of the side of the bundle connecting with the parenchymous system as the face.) I have not made a sufficient number of observations to enable me to speak authoritatively upon the subject, but in the few instances in which I observed this facing of the bundles, they tended to face the centre in the petiole and mid rib just as they did in the trunk. In order to assume this position the bundles in the lower side of a frond retain the position they have on leaving the trunk, while the upper ones twist one way or another in what seems an endeavor to turn over and face the centre of the new stem—that is, of the petiole.

NOTE:—The preceding discussion is based upon direct personal observation and study of a large number of specimens of the following genera together with others, the botanical names of which I do not at present know:

Acrocomia,	Desmoncus,	Mauritia,
Attalea,	Euterpe,	Maximiliana
Astrocaryum,	Geonoma,	Œnocarpus,
Bactris,	Guilielma,	Oreodoxa,
Copernicia,	Hyospathe,	Raphia.
Cocos,	Iriartea,	

THE LITERATURE OF THE SUBJECT.

DESFONTAINES:

1783–6.—Fragment d'un voyage dans les Régences de Tunis et d'Alger fait de 1783 à 1786, p. 290.

1798.—Mémoire de l'Institut Nacional, Vol. I., 1798, pp. 478–503.

DAUBENTON:

1790.—Mémoires de l'Académie des Sciences, 1790, p. 6656–75.

HUGO VON MOHL:

1824.—"De Structura Palmarum" contained in Von Martius' "Genera et Species Palmarum."

1845.—Same, published in "Vermischte Schriften botanischen Inhalts," Tübingen, 1845.

1845.—"Gelehrte Anzeige" of the Royal Academy of Sciences of Bavaria, 1845.

1845.—Comptes Rendus de l'Académie des Sciences, Vol. I., for 1845, p. 1038.

1849.—Reports and Papers on Botany. Ray Society, 1849. (This is an English translation of the article in "Vermischte Schriften" containing Von Mohl's reply to Mirbel.)

1855.—Bot. Zeitung, p. 873, 1855.

GIUSEPPE MENEGHINI:

1836.—"Recherche sulla Struttura del caule nelle Piante Monocotiledoni," Padova, 1836, Poligrafo IV., pp. 15–19.

1843.—Considerazioni sulla questione attualmente agitata all' academia de Francia fra Mirbel e Gaudichaud intorno alla struttura del tronco delle Monocotoledoni (in Miscellanee di Chemica, Fisica e Storia Naturale, 1843).

1843.—Same, Pisa, Miscell. Med. Chir., 1843 (pte. 2), pp. 197–207.

1843.—Giornale Encyclop. Italiana, Vol. I., p. 17. Written 1843.

LESTIBOUDOIS:

1840.—Études sur l'Anatomie et le Physiologie des Végétaux, 1840.

UNGER:

1840.—Ueber den Bau und das Wachsthum des Dicotyledonstammes, 184, p. 35.

C. F. B. MIRBEL:

1843.—Comptes Rendus de l'Académie des Sciences. Vol. I., 1843, p. 1213.

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CHARLES GAUDICHAUD:

1843.—Comptes Rendus de l'Académie des Sci., 1843, Vol. I., p. 1235.

1845.—Comptes Rendus, 1845, Vol. I., pp. 1375, 1436, 1677.

1844.—Comptes Rendus, 1844, Vol. I., pp. 597, 899.

1845.—Comptes Rendus, 1845, Vol. II., pp. 99, 201, 261.

C. F. P. VON MARTIUS:

1845.—Comptes Rendus, 1845, Vol. I., p. 1038.

MILLARDET:

1865.—Mémoires de la Soc. Imp. de Sci. Nat. de Cherbourg, Vol. XI., 1865.

GUILLAND:

1877.—Recherches sur l'Anatomie comparée et le Developpement des Tissus de la Tige dans les Monocotylidones. Ann. Sci. Nat. Ser. 6, VI., 176, 1877

NAEGELI:

1864.—Beiträge zur Wissensch. Bot. Heft I. Das Deckenwachsthum des Stammes u. die Anordnung der Gefässträger bei den Sapendacien, München, 1864.

SCHACHT:

1856.—Lehrb. der Anat. u. Phys. der Gewächse, pp. 216, 307, 354, 1856.

NAUDIN:

1844.—Ann. des Sci. Nat., 1844, I., 162.

SCHLEIDEN:

Grundzüge, II., 189.

Stated Meeting, May 2, 1884.

Present, 9 members.

President, Mr. FRALEY, in the Chair.

New members, Mr. Baker, Dr. Garrison, and Prof. James, were presented to the presiding officer, and took their seats.

Acceptances of membership were read from

Prof. E. J. James, dated Philadelphia, April 22.
Mr. Wharton Barker, Wynoote, Jenkintown P.O., Apr. 23.
Dr. Joseph F. Garrison, Camden, N. J., April 25.
Mr. Francis Jordan, Jr., Philadelphia, April 25.
Mr. Jno. R. Baker, Philadelphia, April 25.
Mr. Rich. L. Ashhurst, Philadelphia, April 25.
Prof. Henry S. Frieze, Ann Arbor, Mich., April 28.

Mr. Francis Wharton declined membership by letter dated Philadelphia, April 29, assigning as a reason his inability to attend the meetings.

Change of address, Geo. L. Vose, Prof. of Civ. Eng., in the Mass. Inst. of Technology, Boston.

A circular letter to attend its 25th anniversary on the 11th of May, was received from the Offenbacher Verein.

Acknowledgments were received from the Royal Bavarian Academy of Science (two copies of XVI, i; and of 110–113); Holland Society of Science (XVI, i; 112, 113); E. H. R. Peters (114); and the Smithsonian Institution (114).

Envoy letters were receivrd from the Belgian Ministry of the Interior and the Musée Guimet.

A letter was received from Brentano Bros., booksellers, New York city, appointed agent for the Bib. Nat. de Paris, desiring the Society's publications and bill for the same.

A letter of advisement was received from the Royal Institute of Higher Studies at Florence.

Donations for the Library were reported from the Department of Mines, at Melbourne; Royal Society, New South

Wales; Central Bureau of Statistics, and Bibliothèque Royale, at Stockholm; Accademia dei Lincei; Société de Geographie, Revue Politique, and M. Paul Chevallier, at Paris; Victoria Institute, Royal Astronomical Society, Royal Meteorological Society, Mr. William Marriott, and Nature, London; Royal Society of Edinburgh; Boston Society of Natural History; Massachusetts Historical Society; S. E. Cassino & Co.; Library of Harvard University; American Journal of Science; Meteorological Observatory, at New York; New Jersey Historical Society; Franklin Institute, Hibernian Society, Commissioners for the erection of the Public Buildings, Charles A. Ashburner, and Henry Phillips, Jr., of Philadelphia; M. H. Boyé, of Lehigh county, Pa.; the Second Geological Survey of Pennsylvania; Johns Hopkins University, and United States National Museum.

Mr. Phillips made a communication "On a supposed Runic inscription near Yarmouth, N. S.," and exhibited a photograph of a squeeze from it.

Mr. Ashburner exhibited recently printed sheets of Cross-sections, made by the Geological Survey, in Schuylkill and Luzerne counties, and explained some of their curious exhibitions of structure.

Mr. Fraley reported that he had received the Michaux rentes last due (April 1), amounting to $133.39, and had paid them over to the Treasurer.

The pending resolution on change of Order of Business was postponed for consideration at another meeting.

And the meeting was adjourned.

Stated Meeting, May 16, 1884.

Present, 10 members.

President, Mr. FRALEY, in the Chair.

A photograph of Prof. H. S. Frieze, of Ann Arbor, Michigan, was received for the album.

An acceptance of membership was received from Mr. Samuel Dickson, dated 901 Clinton street, Philadelphia, April 20.

Letters of envoy were received from the Batavian Society of Sciences, through the Minister of the Netherlands and the United States Department of State; Fondation Tyler; Central Observatory of St. Petersburg; Musée Guimet, and the United States Census Bureau.

Donations to the Library were received from the Batavian Society of Arts and Sciences; the Royal Academy of Belgium; the Accademia dei Lincei; the Royal Academy of Arts and Sciences in Modena; the Geographical Society at Paris; the Geographical Society at Bordeaux; the Meteorological Council of the Royal Society; Dr. Benjamin Ward Richardson, and London Nature; the Toronto Observatory; the newly organized Bostonian Society in the old State House; the Museum of Comparative Zoölogy; Dr. Samuel Abbott Green; the American Chemical Society; the Meteorological Observatory in New York; the American Journal of Pharmacy; the Pennsylvania Magazine of History and Biography; Mr. Richard Vaux, Mr. Henry Phillips, Jr., Dr. Persifor Frazer; the American Chemical Journal; the American Journal of Mathematics; the United States Naval Institute; the United States Fish Commission; and the American Meteorological Journal.

The death of Dr. Samuel D. Gross, at Philadelphia, May 6,

aged 78 (born July 8, 1805), was announced; and Dr. DaCosta was appointed to prepare an obituary notice of the deceased.

Prof. Cope described the rich collections of vertebrate fossil remains in the Muséo Nacional under the care of Dr. Barcena, and in the Museum of the School of Mines in the care of Prof. Ant. Costino, which he had examined during a recent visit to Mexico—Glyptodon, Mastodon, Elephas, Equus, Llama, Bear, Dog and Deer, and the several genera and species into which they seemed divisible, some of them being undescribed. Important geological points he reserved for another communication.

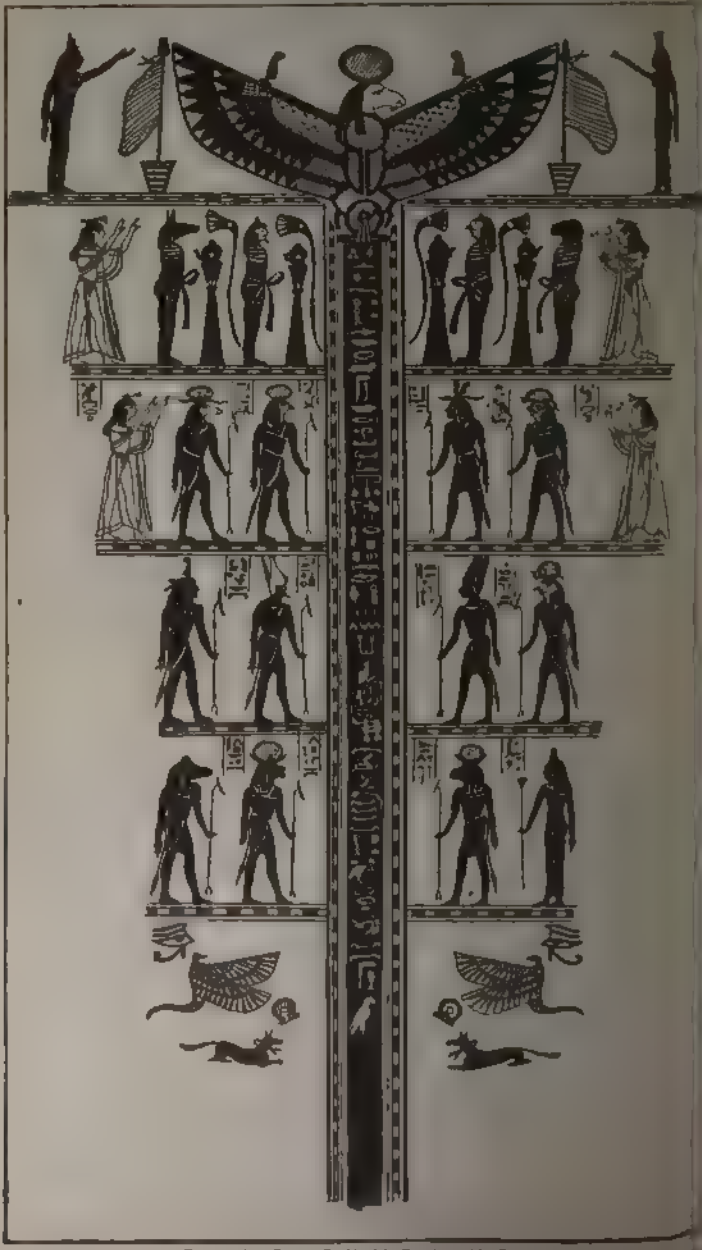
A question from Mr. Hale elicited the opinion, that while no certain proof that man was coëval with either mammoth or elephant had yet been obtained, yet that facts calculated to give the supposition much probability multiplied. The discovery of human facial bones in an uplifted silico-calcareous bed, on the shore of Lake Tescuco, remained incomplete until the beds had been searched for other fossils.

New nominations Nos. 1023 to 1028 were read.

A special Committee on the renovation of the oil paintings in the Hall, consisting of the Curators, with Mr. Phillips and Mr. Rothermel, was appointed and requested to report at the next meeting in June.

A resolution respecting the entertainment of the American Association for the Advancement of Science, by Mr. Fraley, was called up and passed.

And the meeting was adjourned.

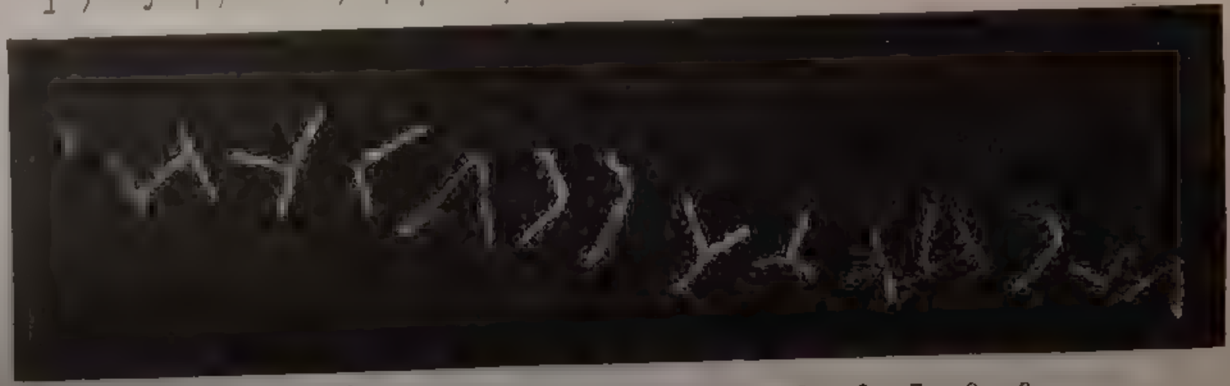


Drawn by Com. E. Y. McCauley, U. S. N

Drawn by Com. E. Y. McCauley, U. S. N.

Supposed Runic inscription near Yarmouth, Nova Scotia.

Photographed from a paper squeeze See Proc. Am. Phil. Soc May 2nd 1884.



Scale of Inches

*On a supposed Runic Inscription at Yarmouth, Nova Scotia.** By Henry Phillips, Jr.*

On the shore of the Bay of Fundy, opposite the town of Yarmouth, stands a rock weighing about four hundred pounds, which, about the end of the last century, was discovered by a man named Fletcher. It has been well known for nearly an hundred years, and those who dwell in its vicinity have always accepted it as a genuine relic of antiquity, no breath of suspicion ever having fallen upon it. The glyphs thereon have been at various times copied and sent abroad to men of learning who have made more or less attempts at deciphering them, more than one savant seeing traces of Semitic origin. In 1875, a rubbing procured from the stone was placed in my hands for investigation. Since that time I have carefully considered the circumstances of the case, and have become ultimately satisfied of its bona fide nature, that the inscription was neither a modern fraud nor the work of the wayward playfulness of the leisure hours of the sportive red skin. Having become imbued with a belief that no deception was intended, or practiced, I entered upon the study of the markings with a mind totally and entirely free from prejudice; so far from believing that the inscription was a relic of the pre-Columbian discovery of America, I had never given any credence to that theory. I therefore approached the subject entirely unbiassed in my opinion, in fact, somewhat prejudiced against the authenticity of any inscription on this continent, purporting to emanate from the hardy and intrepid Norsemen.

The difficulty of interpreting these markings was greatly increased on account of the nature of the material on which the rubbing had been taken, and the fact that in the Runic alphabets the letters frequently have many varying values and forms. But like as in a kaleidoscope, word after word appeared in disjointed forms, and each was in turn rejected until at last an intelligible word came forth, followed by another and another, until a *real sentence* with a meaning stood forth to my astonished gaze. *Harkussen men varu*, Hako's son addressed the men.

Upon examining further, I found that in the expedition † of *Thorfinn Karlsefne*, in 1007, the name of Haki occurs among those who accompanied him. I confess that I was staggered by the remarkable coincidence and began to waver, and the finishing touches were placed to my unbelief when I observed the map, and saw how short the distance was from Iceland to Greenland, compared with the stretch of water from Norway to Iceland. It seemed more than probable that the fearless race that actually did cross the latter expanse of ocean were not likely to be deterred

* The squeeze of the inscription was made by Mr. T. B. Flint, Barrister at Law, of Yarmouth, N. S., and photographed by Mr. F. B. Harden, of Philadelphia.

† On this voyage "they came to a place where a firth penetrated far into the country. Off the mouth of it was an island, past which there ran strong currents which was also the case *farther* up the firth."—Antiq. Americanæ, p. xxxi, Hafniæ 1837.

from navigating the former. As to the reason why such a memento should be left of the visit, of course no definite answer can be given, but it is a fact well known that memorials were often made or erected, engraved or placed at localities where events had taken place, and the address of the chieftain to the men may have been of some noteworthy matter, perhaps even to commemorate the fact of having landed at that spot.

In conclusion, I would say, that the circumstances are worthy of consideration, if not absolutely convincing.

On the Clinton and other Shales, &c., composing the Fifth Group of Rogers in the First Survey of Pennsylvania. By Prof. E. W. Claypole.

(Read before the American Philosophical Society, March 21, 1884.)

This group has been the field for considerable discussion in regard to the proper place of its different beds when compared with those supposed to be of similar or nearly similar age in New York. It has not been easy to prove where one formation began and another ended. By throwing all those shales into a single group Prof. Rogers avoided discussion on this point and No. 5 became a local or Pennsylvanian term. The group has the merit of being a very natural one regarded from a physical standpoint. Based on the massive Medina sandstone, and capped by the conspicuous Lewistown limestone, there was no question of its physical limits in the State, and all further differentiation was postponed.

But with the advance of geology, the necessity arises for closer comparison and correlation. It is not enough to suppose that the fifth group of Rogers corresponds with the New York beds between the top of the Medina sandstone, and the Lewistown or Lower Helderberg limestone. More exact division and definition are desirable, and my recent work in Perry county has put into my hands the means of examining this question in a new method—by the means of the fossils. Palæontology has hitherto done little towards its solution, and by palæontology alone in many cases can the true solution be reached.

In the present paper I propose to examine these rocks constituting the fifth group of Rogers, and to set forth the evidence thus far attainable, both stratigraphical and palæontological, for the places assigned to them among the palæozoic rocks.

The Clinton Group.

Beginning at the top of the Medina sandstone regarding the age of which there has been no question I will consider first the beds lying upon it in Perry county. These are shown in the following section :

Section of the Rocks in Perry County correlated with the Clinton Group of New York.

Fossil hæmatite and limestone		2	feet.
Sandrock		5	"
Hæmatite		1	"
Sandrock		5	"
Upper green shale	Shale, green	160	"
	Iron sandstone	2	"
	Fossil ore	1	"
	Shale, green	200	"
Iron sandstone		10	"
Hard fossil block ore		3	"
Lower green shale		600	"
		989	

Medina sandstone.

The thickness here assigned to the different beds is not a constant quantity, and the diagram does not represent any actual section. It is, with this exception, accurate wherever the whole series crops out in the county. The measurements have been taken or estimated where it was possible to obtain them, and the details may be found in the forthcoming report on Perry county.

COMPARISON WITH THE CLINTON ROCKS OF NEW YORK.

Ft.	*New York.*	Ft.	*Perry Co., Pa.*
18.4	Limestone.	2	Limestone and hæmatite.
		5	Sandrock
		1	Hæmatite.
	Iron Ore.	5	Sandrock.
24.0	Upper green shale.	363	Upper green shale and fossil ore.
15.2	Iron ore and limestone.	13	Iron sandstone and fossil ore.
23.0	Lower green shale.	600	Lower green shale.
	Thickness, 80 ft. 6 inches.		Thickness, 989 feet.

POINTS OF DIFFERENCE.

Diversity of opinion may prevail in regard to the identity of the beds of iron ore on the above diagram, but this is of little moment. They are usually discontinuous and probably their horizons vary. This is the case even within the limits of Perry county and cannot therefore excite surprise at the distance of several hundred miles.

No sandstone is shown on the New York section and little limestone in Pennsylvania, but the sandstones in the latter are thin, only 10 and 20 feet thick respectively, and the same is true of the limestones of New York.

Beds so thin are not likely to be continuous over so great a distance. Such discrepancies are due to difference of conditions during deposition. They are no argument against correspondence.

Points of Resemblance.

It is impossible to avoid noticing the close correspondence, in general, between the two sections looked at as wholes. The lower parts of the two sections are absolutely identical except in thickness. And in Perry county the lower portion includes 965 feet out of the 989 which represent the total mass. In New York it includes 62 feet 2 inches out of the total 80 feet 6 inches. That is, practically, the column presents a close resemblance in the two sections through three-fourths of its length in New York and through forty-nine fiftieths of its length in Perry Co., Pennsylvania. Closer correspondence could not be looked for.

This reduction of its mass also brings the group in Pennsylvania into rather closer resemblance in thickness, to that which it possesses in New York. It is still vastly thicker, but this is the usual condition. If the whole of the shales of the fifth group be included the disproportion is enormous.

The resemblance can be traced even into more minute detail. Prof. Hall describes the *Lower green shale* as consisting of thin smooth laminæ containing lenticular masses of limestone. If sandstone be substituted for limestone, these words exactly describe the Lower green shale of Perry Co. Of the *Lower limestone* he says: "This mass is composed almost entirely of thin beds of impure limestone which alternate with thin layers of green shale." Again the change of the word will adapt the description to the iron sandstone and ore of Perry Co. Of the *Upper green shale* we read (p. 64): "This is readily distinguished from the Lower green shale by its being everywhere fossiliferous;" a statement also true of the two shales in Pennsylvania. The Lower has yielded me almost nothing, while from the Upper I have obtained a fair collection.

Stratigraphically, therefore, it is almost impossible to expect a closer agreement between two correlated beds than that which we actually find here. And unless contrary evidence be found elsewhere, it is not only a reasonable, but an inevitable inference that these beds must be considered equivalents.

Palæontological Evidence.

It is not possible at present to give in full the evidence furnished by palæontology in favor of the classification above adopted. The suspension or termination of the work of the survey in this department will delay for a considerable time the working out of the collection I have made and the making of a larger one. So far, however, as I have been able in the intervals of field work to study this material, it is decisively in favor of the views here set forth. A few details are appended, the parts of the group being taken in order.

Lower Shale.

Omitting the lower shale, in consequence of the scarcity of its fossils so far obtained, and the fact that there is no question of its affinity, I pass on to the next member of the series ascending.

Iron Sandstone and Block Ore.

The Iron sandstone is in some places very fossiliferous, and, aside from the fossils which relate to my present purpose, has yielded me some which promise to be of considerable interest to palæontology. Two species, however, bear on the present subject.

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.

Both are distinctly Clinton species described from that group in New York.

Upper Green Shale.

The three species already recognized from this bed are

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.
Claymene Niagarensis, Hall.

All are Clinton species in New York, the last extending its range into the Niagara group also.

Ore Sandrock.

This rock is in many places abundantly fossiliferous. Again we find

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.

Sandvein Ore Bed.

The same evidence comes from this horizon. I have recognized

Beyrichia lata, Van.
Calymene Clintoni, Van.
Ormoceras vertebratum, Hall.

Thus we find the results of a study of the fossils completely in harmony, so far, with those deduced from the stratigraphy. Clinton fossils range up to and into the Sandvein ore bed.

On the other hand in all these beds I have not yet found a single specimen belonging to any other horizon. Negative evidence is therefore confirmatory. We have consequently palæontological evidence, at present scanty, it is true, but unmistakable, of the persistence of the typical Clinton fauna of New York up to and through the Sandvein ore bed.

LIMIT OF THE CLINTON FAUNA.

At this horizon the Clinton fauna, pure and alone, altogether ceases. Above the Sandvein ore bed (or limestone in some places) comes a mass of green shale and thin hard limestone bands about 150 feet thick, in which fossils are scarce, but from which I have obtained a few species. Among these the only ones yet recognized with certainty are:

Lingula oblonga, Hall.
Beyrichia notata, Hall.

The former of these is a Clinton species in New York, and the latter was described from the Lower Helderberg rocks. We have here, therefore, a mingling of the faunas of the two groups indicating passage beds from one to the other.* This commingling of species is limited, so far as I have yet observed, to the belt of green shales and limestones above mentioned. Immediately over it lies the great (Bloomsburg) *Red shale*, which is almost barren, but which will be discussed below. Here it will suffice to observe that no Clinton forms have been found in it.

Palæontology, therefore, fully bears out the division above adopted for the lower part of this great mass of shales and sandstones, which have been hitherto thrown together into that Limbo of shale, No. 5 of Rogers. The arrangement deduced from the above train of reasoning is as given below:

Table of the Clinton group as proposed for Perry county.

	Onondaga group.	Red shale.
150	Passage beds.	Green shale and limestone.
		Sandvein ore bed.
		Ore sandrock and hæmatite.
989	Clinton group..........	Upper green shale and fossil ore.
		Iron sandstone.
1139		Hard fossil block ore.
		Lower green shale.

These beds are thus correlated, with those in the Report of the First Survey of Prof. Rogers (Vol. I, p. 132), of which they are here considered equivalent.

Onondaga.	Red shale.	Surgent red shale.
Passage beds.	Green shale and limestone..............	Surgent upper shale.
Clinton......	Ore sandrock and ore.	Ore sandstone.
	Upper green shale and ore............	Lower shale, Upper slate.
	Iron sandstone and ore................	Iron sandstone.
	Lower green shale	Lower slate.

* Later examinations render probable the presence of several other Clinton forms in these green shales and limestones, which will give a more decidedly Clinton aspect to the fauna without invalidating the conclusions here reached.

The Onondaga Salt Group, or Gypseous Group of New York, in Perry County, Pa.

Having thus, in appearance, satisfactorily placed the lower portion of Rogers' fifth group on the horizon of the Clinton of New York, I proceed to consider its upper portion.

This, in the district under consideration, consists of a vast mass of shales with almost no variation, except that caused by a few thin layers of sandstone. These shales are red at base, but graduate upward with gray beds, the red color disappearing as we ascend through the series. The lower or red portion is about 700 feet thick, and the upper or gray portion about 150 or 200 feet. These are separated by about 700 feet of what have been called the variegated shales, consisting of alternate beds of red, green and ashen-gray color with a few interbedded sandstones.

It would be of course natural to correlate this shale with the limestone immediately overlying the Clinton in New York, but for reasons, which will appear presently, I have preferred to make it the equivalent of the Onondaga group of New York, which immediately overlies the Niagara, and thus to leave the latter unrepresented in Perry county.

Stratigraphical and Lithological Evidence.

The Onondaga group of New York consists, like that just described, of a mass of variegated shales, and, as some of its names imply, it there yields salt and gypsum. Its total thickness, given by Vanuxem in the Report of the Third District, is about 700 feet, and it is divided as shown below. The section in Perry county is given in another column for comparison.

New York.	*Perry County, Pa.*
Magnesian rock = Limestone with Stylolites.	
Gypseous bed (upper). Porous (vermicular) limerock. Gypseous bed (lower).	Gray, calcareous marl.
Variegated shale (red and green).	Variegated shale (red and green).
Red shale.	Red shale.
Thickness 700 feet.	Thickness 1600 feet.

Very close correspondence exists between the beds at the two places. At both they consist, at base, of a thick mass of red shale. At both, overlying the red shale is another mass of varying color. At both, these two beds form the bulk of the group. So closely do the two sections resemble one another, that the description given of these lower beds in New York may be copied and applied literally to those in Perry county.

Mr. Vanuxem says (Report on Third District of New York, p. 96) of the red shale:

"The great mass is of a blood-red color, fine-grained, earthy in fracture, breaking or crumbling into irregular fragments."

And of the variegated shale he says (p. 97):

"It consists of shales and calcareous slate of a light green and d[illegible] color, intermixing and alternating with the red shale at its lower part

"Thus we have at the top of the series, green, then red under it, green, then red, bluish, green and yellow, this latter by exposure to the air then green and red layers with a little white and greenish sandstone, being several repetitions of the first two, and finally red shale as the lowest visible mass."

No better description can here be given of these two shales as they occur in Perry county.

The thickness of the separate beds is not given in Vanuxem's Report but the total mass varies from 700 to 1000 feet. In Perry county the two lower masses—the red and variegated shales—measure 1400 feet, making the whole group, as usual, much thicker in Pennsylvania than in New York.

Again (p. 97). "In several localities the red shale shows numerous green spots, varying from one inch or less to several inches in diameter.

"The red shale presents a thickness of from one to nearly 500 feet, yet nowhere has a fossil been discovered in it, or a pebble or anything extraneous, excepting a few thin layers of sandstone."

Similar green spots occur in the red shale in Perry county (near Wagoner's mill, for instance). The great scarcity of fossils is also remarkable, though these are not totally absent in Pennsylvania as will be mentioned farther on.

Advancing one step more let us compare the third division in Perry county with the similarly situated beds in New York. Here again we find the description of Vanuxem applicable to a great extent. He says (p. 99):

"The great mass of the deposit consists of rather soft, yellowish or drab and brownish colored shale and slate, both argillaceous and calcareous." It contains "argillaceous and calcareous slates, and more compact masses, which are hard." So in Perry county, though seldom exposed, this is the nature of the mass.

But one very important difference in these gray marls at the two places must be mentioned. No trace exists in this part of Pennsylvania of those concretions of gypsum which characterize the upper part of the Onondaga in New York, and which, together with its brine springs, render it the most valuable stratum in the State. These gray shales contain no valuable mineral, except the lime which enters largely into their composition. Such deposits as the gypsum and salt in New York rarely extend over very great tracts of country. Their absence in Perry county is not an objection sufficient to invalidate the argument. Indeed, the gypsum is not present over all the Onondagan outcrop in New York. Professor Hall says (Geol. of 4th District, p. 126), "There is a considerable space in the western part of Monroe county where no beds of gypsum are known."

Gypsum and salt, like iron ore, occur usually in scattered and discontinuous beds.

No closer correspondence can reasonably be looked for than that which I have here established between the Onondaga rocks in New York and those in Perry county, which I have placed in correlation with them. Only the uppermost stratum, called the Magnesian limerock, is unrepresented in the Pennsylvanian section. This is of inconsiderable thickness, measuring only twenty-four feet.

Palæontological Evidences.

The great barrenness of these shales, which has been already alluded to, prevents the production of very strong evidence derived from their fossils. Only a single species bearing on the subject has rewarded a considerable amount of search. This is *Leperditia alta*, Conrad, which has been found in the Red shale in a few places abundantly, near Buffalo Mill, for example, in Saville township. It is also found in the second division—the Variegated shale—in Centre township, and becomes exceedingly abundant in its upper part, whole slabs being completely covered with its casts. These gray shales afford few opportunities of examination, but this species runs up into and through the massive limestones, forming in this county the lowest division of the Lower Helderberg rocks or Water Lime of New York. Above this horizon I have not found it.

In regard to this species Vanuxem says (l.c. p. 99):

"'At one place only I succeeded in finding fossils in the second deposit (the Variegated shales), 'consisting of Cytherinæ' (Leperditiæ) about half the size of those in the group above."

In this respect, therefore, the correspondence is exact.

No fossils having been reported from the Red shale in New York, the presence of *Leperditia alta* in those of Perry county is not without interest, though it supplies no additional means of identification.

It has been mentioned that *Beyrichia notata* occurs in the passage bed below the Red shale. It may, therefore, be looked for in the Onondaga group, but I have not been able to find it. Its range, at present, is from the passage shales to the basal beds of the Lower Helderberg in Perry county, but it is yet known only in its extreme limits.

Summing up the evidence now presented, it is impossible to dispute the inference that the rocks above described are the real equivalent in Perry county of the Onondaga series in New York. By adopting this view, order is introduced into a mass of deposits hitherto the home of much confusion and uncertainty.

Below is added the correlation of these rocks with those of the First Survey.

Gray calcareous shale	Scalent gray marls.
Variegated shale.	Surgent variegated marls.
Red shale.	Surgent red shale.

The Niagara Group of New York absent from Perry County, Pa.

From the identifications here established it follows that nothing is left to represent the Niagara group in Perry county. If such a representative existed it must lie on the top of the iron ore capping the Clinton group. But the green shale of the passage beds has yielded no fossils that can belong to a bed of that age. It holds, as above shown, a mingled fauna of the Clinton and Lower Helderberg ages. There is, consequently, no conclusion possible, except to infer the absence of the Niagara group from Perry county.

The rapid thinning of the Niagara rocks in New York to the eastward prepares us for this cônclusion. Two hundred and forty feet thick at Niagara Falls, it dwindles down to about one hundred and thirty feet in Wayne county, near Rochester. No other exposure occurs until we reach the slope of the Cincinnati anticline in Southwest Ohio, where it scarcely exceeds fifty feet.

The Upper Limit of the Onondaga Group.

It is scarcely necessary to follow this subject further, as no doubt exists concerning the age of the mass of Limestone overlying these shales. The Lower Helderberg group in Perry county has a well-defined summit, being capped by the Oriskany sandstone, but an ill-defined base where it meets the Onondaga gray shales. Difference of opinion, consequently, may exist concerning the exact plane at which the separation should be made. A short statement, therefore, of the facts and argument bearing on this point is appended.

The Lower Helderberg rocks in Perry county as here defined, consist of the following:

10′	White flint shales.	*Oriskany Sandstone.*
80′	Yellow flint shales.	
8′	Black cherty limestone.	*Lower Helderberg* 348′.
150′	Lime shales.	
100′	Massive limestone.	*Onondaga Gray Shales.*

Regarding the age of all these beds, except the lowest, there is no room for doubt.* The Lime shales and the White flint shales both abound in the fossils that characterize the Lower Helderberg group in New York. The following partial list is sufficient to support this assertion.

Fossils Common to the Lime Shales of Perry County, Pa., and the Lower Helderberg Rocks of New York:

Discina discus, Hall.
† *Strophomena rugosa*, Dalman.
Rensselaeria mutabilis, Hall.
Rhynchonella nucleolata, Hall.
Rhynchonella formosa, Hall.
Merista lævis, Vanuxem.
Merista bella, Hall.
Megambonia aviculoidea, Hall.
Murchisonia minuta, Hall.

* This doubt is now removed by the note added below.

† This species and *Spirifera macropleura*, Con., abound in the White flint shale.

In regard to the lowest bed given in the section above, it must be admitted that in the determination of its horizon palæontology affords very little aid. Still palæontology is not our only guide in the solution of such problems. Indeed, she is only at best a guide whose authority is borrowed from stratigraphy, but nevertheless invaluable and indispensable.

COMPARISON OF THE LOWER HELDERBERG BEDS OF NEW YORK WITH THOSE REFERRED TO THAT GROUP IN PERRY COUNTY, PA.:

	New York.	*Perry County, Pa.*
Lower Helderberg.	Upper Pentamerus limestone.	
	Encrinital limestone.	Flint shales with Crinoids.
	Delthyris shaly limestone.	Lime shales.
	Lower Pentamerus limestone.	
	Water lime (Tentaculite bed.)	Massive limestone.
Onondaga	Magnesian rock.	
	Vermicular rock.	
	Gypseous marls.	Gray calcareous shale.

If the identifications previously made are accepted, there is no alternative but to admit the correlation of the Massive limestone with the Water lime, or to deny it any equivalent in the New York series. It is so closely connected with the overlying lime shales that to separate these would be in the highest degree illogical. They graduate into one another and can only be distinguished by the thinness of the beds and the abounding fossils of the upper strata. Their physical resemblance to the water lime is exceedingly great, but nowhere in Perry county have I been able to find any hydraulic beds. All slake equally when burnt.

PALÆONTOLOGICAL EVIDENCE.

In a case when stratigraphical evidence is so conflicting, the slight aid which palæontology can afford becomes exceedingly valuable. The Massive limestone being almost barren of fossils, the argument must rest on one or two species.

The Water lime is characterized in New York by abundance of *Leperditia alta*. As already mentioned, this fossil occurs for the last time, so far as yet observed in Perry county, in the massive limestone, where it is very abundant and often very large.

Occasionally, also, corals have been seen in this limestone, resembling species occurring in the lime shales above it, thus forming a link between the two. Below this limestone no fossils of this kind have been found in the shales.

Considering the high probability that this class of evidence would be increased by closer and wider search, especially in other counties, there can be no doubt that this Massive limestone should be included in the Lower Helderberg group of which it must then form the base. (See note, p. 502.)

If, however, any should prefer to relegate it to a system of "passage-beds" connecting the Onondaga and the Lower Helderberg, no valid objection can be raised to the course pending the discovery of further and conclusive evidence. It will not affect the arrangement above proposed.

I must remark in conclusion, that the suggestions now made are provisional, and therefore subject to change, according to future evidence. It does not seem probable, however, that the main outline of the plan will be altered.

Note. Since this paper was written I have obtained an excellent specimen of *Pterygotus Osborni*, Hall, from the massive limestone of Juniata county. This may be considered a proof of the identity of this limestone with the *Water lime* of New York. For this specimen I am indebted to Mr. Jas. Stevenson of this city (Akron, O.), a former resident of Juniata county, Pa.

Summary of the Grouping detailed above.

	New York.	*Perry County, Pa.*
Lower Helderberg Gr.	Upper Pentamerus limestone.	
	Encrinital limestone.	Flint shale with Crinoids
	Delthyris shaly limestone. Lower Pentamerus limestone.	Lime shales with *Tentaculites*, *Merista tella*, &c.
	Water lime (Tentaculite bed).	Massive limestone with *Pterygotus* and *Lep. alta*.
Onondaga Gr.	Magnesian rock.	
	Vermicular rock.	
	Gypseous marls.	Gray, calcareous shale.
	Variegated shale	Variegated shale.
	Red Shale	Red shale
		Passage-beds.
Clinton Group.	Limestone	Limestone and hæmatite.
		Sandrock.
	Iron ore.	Hæmatite
		Sandrock.
	Upper green shale.	Upper green shale and fossil ore.
	Iron ore and limestone	Iron sandstone and fossil ore.
	Lower green shale.	Lower green shale.
	Medina sandstone.	

ERRATUM.

In Mr Branner's paper on the growth of the Palm, for *Guilland*, read *Guillaud*, and for *Ser. VI. 176, 1877*, read, *Ser. V, 1—176, 1877.*

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve Councillors and other officers of the Society, and having received the report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given by public advertisement), proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then depending, or who hath not previously declared to the Society that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment, or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the Society, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object or subject matter of the communications, so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure, in any year, of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accumulation of premiums shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of——A. D.——." And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the Treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The Treasurer shall credit the said fund with the interest received on the investment thereof, and if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for the addition, to the said premium, of such amount as the Society may from time to time think suitable, or for the institution of other premiums.

The Treasurer shall, at the first stated meeting of the Society in the month of December, annually, make a report of the state of said fund and of the investment thereof.

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

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EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges ; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

Synopsis of the Species of Oreodontidæ. By E. D. Cope.

(Read before the American Philosophical Society, January 18, 1884.)

The tribe Ruminantia first appears in the White River Miocene period in North American geological history. It is represented there by a number of genera, which pertain to several family types. The most aberrant of these, the *Oreodontidæ*, includes the largest number of forms, generic and specific. The *Poëbrotheriidæ* certainly embraces but few species, while a third group of genera, represented by Leptomeryx, which are intermediate between the *Tragulina* and *Pecora*, and should be perhaps regarded as aberrant *Tragulidæ*, also includes a small number of species.

The *Oreodontidæ* constitute a family related to the *Anoplotheriidæ* of the later Eocene, but representing a more specialized condition of the structure of the molar teeth, in the full development of the selenodont type, which is rudimental in the *Anoplotheriidæ*. Their feet, on the other hand, are less specialized than in the latter family. A . a family, the *Oreodontidæ* display very little tendency in their limbs to the specialized condition of the *Ruminantia*, but are more like those of the suilline groups, and, among recent families, of the *Hippopotamidæ*.

OREODONTIDÆ.

Dentition; superior incisors present; molars selenodont. Cervicals with the transverse processes perforated by the vertebrarterial canal. No alisphenoid canal. Ulna and radius, and tibia and fibula distinct. Metapodial bones four on each foot, with incomplete distal trochlear keels. Lunar bone not supported by magnum. Navicular and cuboid bones distinct.

The preceding synopsis of its characters should furnish a basis for the definite location of the *Oreodontidæ* in the system. Dr. Leidy called its species Ruminating hogs, and created a family for Oreodon and the allied genera, under the name of *Oreodontidæ*. This family is adopted by Prof. Gill who includes in it the *Agriochoeridæ* of Leidy, and places it in his division *Pecora*, which is more comprehensive than the *Pecora* of Prof. Flower, being nearly identical with the *Selenodonta* of Kowalevsky. More precise expression of its affinity to the existing families is not given, excepting to place it under a division "incertæ sedis."

As a selenodont type, this family is excluded from the *Artiodactyla omnivora*, and as having its metapodial bones distinct, it cannot be placed in any recent family excepting the *Tragulidæ*. From this family it is distinguished by the distinct ulna and radius. We then turn to the extinct families *Poëbrotheriidæ* and *Anoplotheriidæ*. The former agrees with the *Tragulidæ* excepting in its Cameloid cervical vertebræ, while the latter differs from the *Oreodontidæ* in the structure of the feet. The *Anoplotheriidæ* are didactyle in front, and tridactyle behind. The posterior foot has a well-developed second digit directed

more inwards than the others, which it is supposed supported a natatory web. In the Oreodontidæ all the feet are regularly tetradactyle.* The Anoplotheriidæ differ also in the presence of an additional cusp on the inner side of the superior molars, accompanied by an imperfect development of one or both pairs of the internal crescents. In *Anoplotherium* the internal crescents of the inferior molars are incomplete, and more or less represented by tubercles. In the *Oreodontidæ* there are two pairs of fully developed crescents, and no internal tubercles. The details of the structure express various affinities. The axis is intermediate between that of the suilline and ruminant *Artiodactyla;* the other cervicals are suilline, while the remaining vertebræ are ruminant. The scapula is ruminant, not suilline; while the humerus is like nothing but *Anoplotherium.* The radiocarpal articulation is intermediate between that of hogs and ruminants. The unciform supports the lunar bone. The sacrum is ruminant, the ilium suilline. The femur and tarsus are much like those of the peccary.

The genera of this family known to me are the following:

I. Orbit incomplete; last premolars in both jaws with two external crescents or Vs.

Premolars three.......................................*Coloreodon.*
Premolars four.......................................*Agriochoerus.*

II. Orbit complete; premolars four, the fourth with one external crescent.

a. No facial vacuities.

Premaxillaries distinct; otic bullæ not inflated.....................*Oreodon.*
Premaxillaries distinct; otic bullæ inflated.....................*Eucrotaphus.*
Premaxillaries coössified; otic bullæ inflated.....................*Meryeochoerus.*

aa. Facial vacuities present.

Premaxillaries coössified, dentigerous; vacuities prelachrymal only.......................................*Merychyus.*
Incisors six above, persistent; vacuities prelachrymal and prefrontal; nasal bones much reduced.....................*Leptauchenia.*
Incisors very few, caducous; vacuities very large.....................*Cyclopidius.*

III. Inferior premolars three.

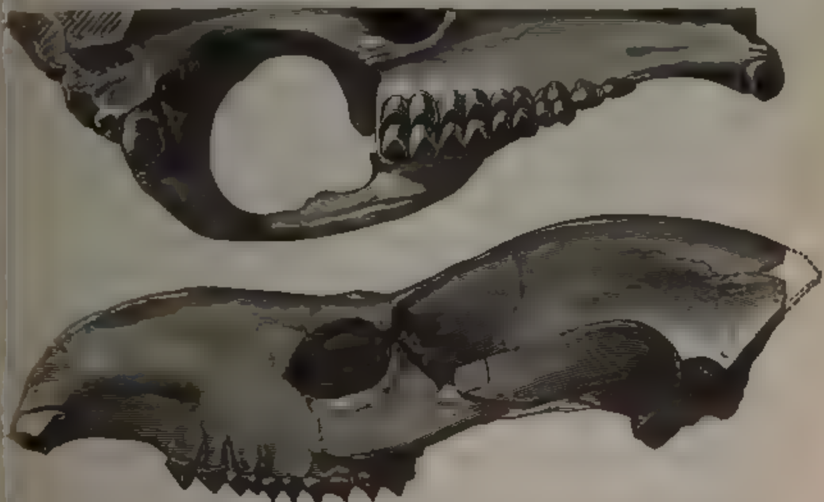
True inferior canine functional; inferior incisors one on each side. *Pithecistes.*

The number of species referred to these genera in the succeeding pages is as follows:

Oreodon	3
Eucrotaphus	3
Merycochœrus	7
Merychyus	6
Leptauchenia	3
Cyclopidius	2
Pithecistes	3
Agriochoerus	6
Coloreodon	2
	35

* I have observed this in the genera Oreodon, Eucrotaphus, Merycochœrus, and Merychyus.

The present paper is chiefly devoted to the proper distinction of these species and genera or cranial characters only. Figures of all will be given in my volume which embraces this subject, in the Report of the U. S. Geological Survey of the Territories.



Oloreodon ferox Cope, one half natural size. Original; from Report U. S. Geolog. Survey Terrs., vol. III, F. V. Hayden in charge.

OREODON Leidy

Proceedings Academy Philadelphia, 1857, p. 238. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 29. Extinct Mammalia Dakota and Nebraska, 1869, p. 72. Report U. S. Geological Survey Terrs., 1873, I. p. 201. *Merycoidodon* Leidy, Proceeds. Acad. Philada., 1848, p. 47 (nomen nudum). *Cotylops* Leidy, Loc. cit., 1851, p. 239.

Premaxillary bones distinct from each other. Otic bullæ not inflated. No lachrymal vacuity of the face; nasal bones normal. Premolars four in both jaws.

Dental formula I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$: the series uninterrupted. Crowns of the molars robust, well distinguished from the roots. Grinding surface of the true molars simply selenodont, *i. e.*, with but two pairs of crescents. Superior premolars composed of a single external compressed cusp with crescentic section, and internal cingula or crescent. The fourth premolar with a well developed internal crescent; the first three with rudimental internal crescents in the form of basal cingula. Superior canines distinct. Inferior premolars of two kinds, the first canine like in form and function, the others consisting of a single external cutting edge rep-

resenting two crescents, of which the anterior has its posterior horn developed as an obliquely transverse crest directed inwards. Last true molar with a heel composed of two columns.

In the superior temporary dentition the last premolar has the form of the first permanent true molar. The third premolar has five lobes, *i. e.*, four crescents and an anterior odd one. The other temporary premolar resembles that of the permanent series. The last inferior temporary premolar has the three pairs of lobes usual in the *Artiodactyla*, and the two which precede it resemble the corresponding permanent teeth. Says Leidy :* "The permanent true molars successively protrude and occupy their functional position before any of the deciduous molars are shed. The displacement of the latter by their permanent successors appears to begin with the eruption of the last of these, which is followed by those in advance. The first permanent premolar of the upper jaw appears to have protruded after the deciduous teeth, and occupied a position with them in the functional series, but remains after these are shed."

The cranial characters which belong to *Oreodon* as a genus are the following : Orbit completed behind ; temporal fossæ separated by a sagittal crest. A lachrymal fossa, but no facial nor frontal vacuities. Premaxillary bones distinct from each other and from the maxillaries. Nasal bones well developed. Auditory bullæ not inflated.

The preceding dental and cranial characters have been pointed out by Leidy in his various palæontological works. On account of the absence of the necessary material he was unable to give the characters of the remaining parts of the skeleton. These are of course necessary to a correct estimate of the affinities of the genus, and I will endeavor to add such information as my material will permit. This consists of numerous more or less complete skeletons found in connection with the skulls by myself in Colorado in 1873.

Vertebræ. The *cervical* vertebræ are rather short, and the character of the articulation of the centra slightly opisthocoelous, and the articular faces are quite oblique. The axis is the longest vertebra ; the three last centra are subequal in length. In one of my series the seven cervicals are preserved. In all of these, excepting the seventh, the bases of the diapophysis are perforated by the vertebrarterial canal. In the sixth vertebra, the decurved parapophyses are especially robust. The axis and three succeeding centra display strong hypapophyses at their posterior extremities, which are carried forwards as strong median keels. The odontoid process is depressed so as to have a lenticular section ; it is not excavated above, but in my largest specimen the internal borders of the facets for the atlas are continued so as to enclose a short groove on each side at its base. In one smaller and immature specimen this is wanting. The vertebrarterial canal of the axis is enclosed as in the other cervicals. The canal for the second spinal nerve has a narrow roof, but there are no canals

* Ancient Fauna of Nebraska, p. 11.

for the succeeding pairs of nerves perforating the neural arches. The atlas is not very elongate. The base of the diapophysis has a perforating canal, which issues in a large inferior fossa. The vertebrarterial canal then perforates the diapophysis upwards anterior to the middle of the base, and then soon enters the neural canal just posterior to the superior margin of the cotylus of the occipital condyle.

The centra succeeding the cervicals increase gradually in length posteriorly. Those of the anterior part of the dorsal series are quite depressed, but the vertical diameter rapidly increases, so as to be equal to the transverse in some of the lumbars. A trace of the opisthocoelous articulation exists throughout the dorsals but is very little marked in the posterior centra. There are no hypapophyses on the dorsals, but on one of them, probably the third, the inferior and lateral faces are separated by a strong angle, which is strongest anteriorly, giving the articular face a subquadrate outline. The rib-bearing diapophyses are robust. On the posterior dorsals the capitular and tubercular surfaces are confluent, forming a narrow facet on the anterior face of the diapophysis, in a manner not seen in *Cervus elaphus* or *Sus scropha*. The centra of the lumbars, after lengthening, become shorter immediately in front of the sacrum. The vertical diameter of one or two posterior ones is less than that of the anterior ones. The greater number of the lumbars display a small compressed hypapophysis at their anterior extremity; but this is wanting on the posterior ones. The neural arches of the dorsal and lumbar vertebræ are nowhere perforated for the spinal nerves.

The lumbar prezygapophyses embrace the articular faces of the posterior ones, which have a section of one side (below), the end (external), and a half the other side (above), of a transverse ellipse. The superior recurved surface does not appear.

The sacrum consists of five vertebræ, with very depressed centra. The ilium is attached to the diapophysis of the first, and a small anterior portion of that of the second. That of the fourth is flat and free. The anterior zygapophysis of the first displays a slight degree of the superior incurvature general in *Artiodactyla*. The caudal vertebræ were numerous, forming a long tail. The proximal ones are moderately depressed, while more distal ones with wide diapophysis and complete neural arch, are subcylindric, and more elongate. The number of vertebræ preserved in the most complete of my specimens, is as follows:

	Cv.	D.	L.	S.	Cd.
O. culbertsoni ad..........	7	5	6	4	4
O. culbertsoni juv.........	5	8	6	2	1
O. gracilis..............	4	5	3	*	*
O. g. coloradoënsis.......	7	8	6	5	3

An anterior, perhaps second, *sternal segment* is flat and subquadrate in outline, with large hæmal articular face of the lateral margin anteriorly, and a small one posteriorly. No inferior carina.

The spine of the *scapula* rises abruptly from the neck as in Ruminantia, and the coracoid process is short and obtuse. The spine continues to the distal extremity, which is regularly convex.

The most perfect *innominata* in my collection are deficient in the symphysis. The form of the ilium is more that of a hog than of a ruminant. The peduncle is even stouter, and the superior border is abruptly expanded below the middle of the length of the bone. The superior and inferior borders are subparallel as in the hog, and not divergent as in the ruminants. The anterior edge is acute, and uninterrupted by an anterior inferior fossa or spine. The pubis is robust and transverse, and without prominent basal pectineal tuberosity. The incisura acetabuli invades the base of the pubis a little, but the ischium more extensively. The obturator foramen is quite large. The distal border of the ischium is obliquely truncated as in many other Artiodactyla, and more nearly resembles that of the peccary than any other recent form I have observed. The tuber proper is a convex edge, not thickened, and its superior edge is continued into a strong up-looking tuberosity. This region is not so robust as in most recent forms.

The *humerus* of *Oreodon* is readily distinguished from that of recent *Artiodactyla* by several peculiarities. The greater tuberosity is large, rising above the head; and is incurved, terminating inwards in an acuminate apex. Its border at the base is thrown into an obtuse angle. The lesser tuberosity is small, and is well separated from the greater by a deep and wide bicipital groove. The deltoid ridge is distinct. The condylar extremity is more transversely extended than in any recent Artiodactyle, owing to the fact the posterior interior distal tuberosity is placed interior to the trochlea instead of partially behind it, and that there is, in addition, an internal epicondyle not seen in the recent suilline or ruminant members of the order. The intercondylar ridge is strong, and wider than in most recent ruminants; in the suillines it has nothing like such a development. Another peculiarity is the flange-like free border of the external trochlea, which is especially recurved at its superior part.

The *radius* is distinct from the ulna throughout. The relation of the ulnar to the radiocarpal surface is posterior as well as exterior; the common suture of the two, making an angle of 45° with the long axis of the radiocarpal surface. The head is a transverse oval, with the inferior face forming a regular curve without notch. Its articular surface is divided into three portions in adaptation to the internal and external humeral trochlear and the wide median ridge. The external face is beveled forwards above, to fit the flange-like projection of the external trochlea. The shaft of the radius is not very stout, and has a nearly equal transversely oval section to near the distal expansion. Here are wide grooves for the extensor tendons, one superior, the other obliquely exterior. The carpal articular facet has the general ungulate characters. The scaphoid facet is concave above, convex and condyloid below, and is only distinguished from the

lunar facet by a contraction of the anterior and posterior borders. There is no indication of distinguishing ridge between the lunar and cuneiform facets. The posterior border at their junction is prominent, enclosing a fossa with the scaphoid condyle, which does not, however, excavate the intervening surface. The scaphoid condyle is not divided by a ridge.

The *ulna* gradually contracts distally from a robust olecranon. The shaft beyond the humeral cotylus has an oval section, with its long axis forming an angle of 45° to the perpendicular. The olecranon is short and compressed, its posterior border rising nearly as high as the coronoid process. The edges of the humeral cotylus are not flared beyond the shaft.

In the *carpus* the unciform nearly reaches the scaphoid, which is supported by the magnum and trapezium.

The great trochanter of the *femur* is not produced beyond the line of the head, and is well recurved, enclosing a large fossa. The little trochanter is large. The *fossa ligamenti teris* is submedian, subround and large. Distally, the patellar trochlear groove is quite elevated; its lateral crests are of equal prominence, and nearly equal superior prolongation. The patellar groove is continued some distance above the crests, but there is no fossa in this region as in the hog. The popliteal fossa is well marked, and the condyloid articular surfaces are not entirely cut off from the rotular. The external linea aspera terminates first in a rugose muscular insertion, and then in a shallow fossa a short distance above the condyle. There is no crest nor deep fossa. This element is more like the corresponding one in *Dicotyles torquatus* than in any other mammal. The patella is a short wide bone, with a large anteroposterior diameter. One extremity is acute, the opposite one truncate.

The head of the *tibia* is also like that of *Dicotyles*. The spine is divided as usual, and not much elevated; the crest is prominent, but is wide and truncate above at the head. It is not excavated as in *Sus*. The external tendinous notch is well marked. The external margin of the shaft does not display any sutural surface for the fibula. The surface of attachment of an external malleolus is distinct. The internal malleolar process is narrow and is produced well downwards. The anterior intertrochlear angle is prominent; the posterior only convex. The trochleæ are deep, the outer being both the wider and the deeper.

The *astragalus* presents well marked characters. The distal extremity displays the two usual parallel trochleæ, which are separated by a pronounced angle. The cuboid trochlea slopes somewhat backwards, while the navicular is strongly concave. The tibial trochleæ are unequal, the internal being smaller than the external. It is separated from the latter by a constriction which is well rounded and not angulate as in the hog. The external side of the astragalus displays a wide malleolar band, a wide posterior and narrow anterior calcaneal facets, and an undivided concavity intervening between the latter. On the inner side, the malleolar face

descends to below the middle, as in *Hypertragulus*, and there is no vertical nor horizontal distal crest. The inferior calcaneal facet is undivided and not grooved, and does not extend over the internal border of the inferior side of the bone. It exhibits an acute border on the external side. The calcaneum is rather elongate, and the free portion is compressed and with obtuse margins above and below. The transverse astragalar process is not large and is not produced beyond its facet. The ascending plate is well developed and has a superior, uninterrupted convex facet for the fibula, with a narrow facet on its inner side. The inner distal astragalar facet extends the entire length of the cuboid facet. There is a low longitudinal ridge on the external side of the distal end of the calcaneum.

The *navicular* and *cuboid* bones are distinct from each other and from the ectocuneiform. The astragalar ligamentous fossa is in the naviculo-cuboid suture. The inferior proximal angle of the cuboid is produced posteriorly, and the peroneal process well forwards. The ectocuneiform is distinct, and much wider than long. The mesocuneiform is exterio-posterior in position, and the transverse diameters are small. It is produced distally, overlapping the head of the second metatarsus. Entocuneiform wanting. The metapodial bones are entirely distinct. The lateral metatarsals are well developed. The second articulates with both the ecto- and mesocuneiform bones, by a proximal extremity which is laterally compressed. The third and fourth are subequal in width, and articulate exclusively with the ectocuneiform and cuboid respectively. The fifth metatarsus is compressed proximally, and the external part of its extremity articulates with a lateral fossa of the cuboid. The distal articular extremities of the metapodials are separated from the anterior face of their shafts by a transverse groove, and they have a well marked articular fossa on each side. The trochlear tongue only exists on the posterior face, where it is prominent and compressed. It disappears on the middle of the distal end, and is wanting on the anterior face. The phalanges are depressed proximally, the penultimate ones distally also. The ungues are rather depressed and have convex external borders. There is a pair of sesamoid bones below the distal articular extremity of the metatarsals.

History. The dental and cranial characters of this genus were fully described by Dr. Leidy in 1852, as already cited. In the Extinct Mammalia of Dakota and Nebraska, published in 1869, Dr Leidy added the following points in the osteology of the skeleton of the *Oreodontidæ* (p. 72). "What are supposed to be the bones of the forearm and leg are discrete, as in the hog, and the bones of the feet correspond in number with those of this animal." In 1873* Prof Marsh confirmed these statements so far as regards the metacarpal bones, and added that "the navicular and cuboid bones were loosely coossified or separate." The structure of the vertebræ, and of the greater part of the scapular and pelvic arches.

* Amer. Journ. Sci. Arts, p. 409.

with the carpus, tarsus and feet, with the exceptions above noted, are now described for the first time.

This genus appears first in time in the known history of the family, and presents us with its primitive or least specialized characters, or those nearest the average condition of the ordinary primitive ungulate.

Species. The species of this genus are difficult to discriminate from the evidence of crania alone, and their true number will remain uncertain until we can study entire skeletons. My material enables me to make some progress in this direction. After the removal of the forms with inflated bullæ to the genus *Eucrotaphus*, there remain the two species originally referred to Oreodon by Leidy, the *O. culbertsoni* and the *O. gracilis*. To these Leidy subsequently added two others, the *O. affinis*, which is intermediate in size between the two named, and the *O. hybridus*, of larger size than either. As the condition of the otic bullæ in the last is unknown, its generic reference is not certain. All these forms are from the White River epoch of Dakota, Nebraska and Wyoming.

My material is largely from the White River beds of Colorado. I find from this region the true *O. gracilis* and the *O. culbertsoni*, abundantly represented. Besides these there is a form intermediate between the *O. gracilis* and the *O. affinis*, which is nearer the former than the latter. Of *O. gracilis* there are two skulls complete; of the form next larger, which I call *O. gracilis coloradoënsis*, two complete crania (one with skeleton), and a face with teeth. Of a form between the *O. affinis* and the *O. culbertsoni*, there are four skulls complete (two with skeletons); and of *O. culbertsoni* proper, numerous parts of skulls with teeth, but none complete. No other regions which I have explored have produced these species; not even the Ticholeptus beds, where they might have been reasonably expected to occur.

The distinction of the previously known species will remain as Leidy has left it, with certain reservations in the matter of dimensions; while I add two sub-species.

Nasal bones obtuse posteriorly; frontals little produced on either side of them; true molar teeth not exceeding M. .035 in length; canine and premolars .030; width of front .046. *O. gracilis*.

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .037 in length; canine and premolars .039; width of front at middle of orbits .046. .... *O. coloradoënsis*.

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .038; front at orbits .057 in width. .... *O. affinis*.

Nasal bones acute posteriorly; frontal produced to an acute apex on each side of them; molar teeth .040; front, .056. *O. periculorum*.

Nasals and frontals as last; molar teeth .047; front, .050+.. *O. culbertsoni*.

From this table it may be seen that the passage from the small *O. gracilis* to the large *O. culbertsoni* is accomplished by a series of intermediate steps. That these extreme forms belong to one species cannot be admitted without evidence of more complete transition than we yet possess. As above remarked, groups of specimens represent each form and adhere to the definitions given with considerable fidelity. The largest of the specimens I refer to, the form *O. periculorum*, however, reaches .042 in the length of the true molar teeth, and the smallest of the *O. culbertsoni* measures .046. These I must consider as sub-species only. As regards the three remaining forms the length of the true molar series shows a complete gradation. The size of the cranium, as indicated by the interorbital width, is in the *O. affinis* as large as that of the *O. culbertsoni* according to Leidy, and the combination of characters presented by this form, would seem to entitle it to specific rank as suggested by Leidy. On the other hand the form *coloradoënsis* agrees in interorbital width with the small *O. gracilis*, differing from it in the greater length of the muzzle and of the cranium. But here, while the proportions of the premolar teeth distinguish the forms well, the length of the brain-case does not coincide exactly with the other measurements. The measurements of four skulls are as follows: *O. gracilis* No. 1, length of skull M. 114.5; No. 2, .120. *O. coloradonësis* No. 1, .129; No. 2, .135.

Oreodon gracilis Leidy.

Proceedings Academy Philada., 1851, 239; 1853, 392; 1854, 157; 1857, 89; Owen's Report Geolog. Survey, 1852, 550, Pl. XI, figs. 2–3; Pl. XIII, figs. 5–6. Ancient Fauna Nebraska 1853, p. 53, Pl. V, figs. 3–4; VI, figs. 1–7. Extinct Fauna Dakota and Nebraska, 1869, 94, Pl. VI, figs. 2–3.

Abundant in the White River beds of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are distinguished as follows:

Length of superior premolar series, M. .023................ *O. g. gracilis*
Length of superior premolar series, M. .029.......... *O. g. coloradoënsis*.

Oreodon gracilis gracilis Leidy.

Dakota, Nebraska and Colorado.

Oreodon gracilis coloradoënsis Cope.

Colorado.

Oreodon affinis Leidy.

Extinct Mammalia Dakota and Nebraska, p. 105; Pl. IX, fig. 3.

Probably from the White River beds of Nebraska.

Oreodon culbertsoni Leidy.

Owen's Report Geological Survey, 1852, 548, Pl. X, figs. 4–6; XIII, figs. 3–4; Ancient Fauna Nebraska, Smithsonian Contrib. to Knowledge, 1853, 45; Pl. II, III, IV, figs. 1–5, V, figs. 1–2, VI, figs. 8–11; Proceeds.

Academy Philada., 1853, 392; 1854, 35, 157; 1857, 89; Bronn Lethæa Geognostica, 1856, 930. Extinct Fauna Dakota and Nebraska, 1869, p.86; Pl. VI, fig. 1; VII fig. 2; IX, figs. 1–2. *Merycoidodon culbertsoni* Leidy, Proceeds. Acad. Phila., 1848, 47, Pl. II; 1850, 121; 1851, 239. *Oreodon priscum* Leidy, Proceed. Phila., Academy 1851, 238; *Cotylops speciosa* Leidy, Ibidem 239; *Oreodon robustum* Leidy, Ibidem 276.

The White River epoch of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are defined as follows:

Length of superior true molar series from M. .040 to .042. .... *O. c. periculorum.*

Length of superior true molar series from .046 to .050.... *O. c. culbertsoni.*

Oreodon culbertsoni periculorum Cope.

This smaller race or sub-species has as yet only been found in the White River beds of Colorado and Wyoming. I do not detect any differences between it and the Nebraska form other than those of size. The largest measurement of the *O. c. culbertsoni* given in the above table is derived from Leidy; my largest specimen gives .047 as the length of the true molar series.

Oreodon culbertsoni culbertsoni Leidy.

Very abundant in the White River formation of Dakota, Nebraska, Colorado and Wyoming.

EUCROTAPHUS Leidy.

Proceedings Academy Philada., 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 56. *Eporeodon* Marsh, Amer. Journ. Sci. Arts, Vol. ix, 1875, p. 249.

Premaxillary bones distinct from each other. Otic bulla swollen. No prelachrymal or nasal vacuities.

This genus presents us with the first step in the series of modifications which the primitive form underwent with the advance of geological time. It appeared contemporaneously with the earliest representatives of the family, *i. e.*, in the White River epoch, but in small numbers. In the succeeding or John Day epoch the genus Oreodon had disappeared, and the present form had multiplied enormously in individuals, if not in species. Subsequent to that epoch it is unknown.

The greater number of the Oreodont remains found in Oregon belong to this genus. The *Eucrotaphus jacksoni* bore the same relation to the Oregon John Day fauna, as the *Oreodon culbertsoni* did to that of the White River epoch.

The species of Eucrotaphus are distinguished as follows:

I. Palatonareal border well posterior to posterior edge of maxillary bones.

a. Infraorbital foramen above front of P-m. iii.

Skull depressed, muzzle short; paroccipital process behind bulla and not separated from it by grooves; bulla grooved to apex for styloid ligament, etc.; zygoma more robust. *E. trigonocephalus*.

II. Palatonareal border in line with posterior edges of maxillary bones.

aa. Infraorbital foramen above posterior part of third premolar.

Paroccipital process behind otic bulla, the internal border of its base opposite that of the bulla. .... *E. jacksoni*.

Paroccipital process external to the middle of the otic bulla; generally larger. .... *E. major*.

The name here employed for this genus is the one first given with a definition. The typical species, *E. jacksoni*, was widely distributed, and appears under several varietal forms and sizes, some of which have received names. Subsequently to the original description, Dr. Leidy added to the genus a second species, which probably belongs to the genus Agriochœrus. On this account Leidy inclined at one time to combine the two genera, but afterwards abandoned the idea.

Eucrotaphus trigonocephalus, sp. nov.

This distinct form is only known to me from a single skull of an old animal. In the character of its otic bulla it has resemblance to the species of Agriochœrus, while the maxillary part of the skull has the posterior position of a true Oreodon.

The muzzle is rather depressed, and the premaxillary alveolar border is almost transverse. The position of the canine alveolus is swollen laterally, and between it and the infraorbital foramen the side of the face is slightly concave. The expansion leading to the malar bone commences as the posterior slope of the concavity mentioned, and spreads laterally, without interruption, beginning to project beyond the superior alveolar border at the fourth superior premolar. In the *E. jacksoni* this is not apparent anterior to the first true molar. The top of the muzzle and the front are wider than in that species, and are gently concave in the transverse direction. The anterior temporal ridges are well defined, and concave in outline, uniting early to form a prominent sagittal crest. The malar bone is a little concave below the orbit. The malar process of the maxillary projects downwards in an obtuse angle, opposite the penultimate superior molar. In *E. jacksoni* the malar is convex, and the tuberosity is opposite the last molar. The squamosal process is deeper than in the *E. jacksoni*, and sends a more robust apex into the malar bone, the apex not extending in front of the posterior border of the orbit. The supraoccipital crests are well developed, and project beyond the vertical plane of the condyles; they continue into well marked posttemporal crests, as in the other species of the genus, as well as send an obtuse ridge downwards on each side towards the foramen magnum. The median supraoccipital plane disappears downwards in a wedge-shaped apex, which causes the transverse section

above the foramen magnum to be obtuse angulate instead of broadly flattened as in *E. jacksoni*. The mastoid crests are roughened and are vertical, but do not continue directly into the paroccipital processes, but are separated from them by a deep excavation of the external margin, due to the internal position of the base of the process.

The long diameter of the base of the paroccipital process runs outwards and backwards, and it is attached to the bulla at the middle of the posterior extremity without any intervening grooves such as are seen in the other species of the genus. The bullæ are ovoidal in anteroposterior section, the regularity interrupted, however, by the presence of a ridge on the external side directed posteriorly, enclosing a groove which is continuous with the stylohyoid fossa. The ridge continues into the inferior crest of the tympanic bone. The sphenoid bone is regularly convex in transverse section, while the basioccipital is concave on each side with a narrow median keel, which commences opposite the anterior edge of the paroccipital processes. The basicranial axis is not quite in line with the basifacial, but does not present such an angle with it as is seen in the species of Merycochœrus, where the skull is known to me. In this respect it agrees with the other species of the genus. The postglenoid processes are less prominent than in *E. jacksoni*, but have a base more widely extended outwards. The external border is very oblique, since the apex is narrowed. The glenoid region is more extended, both transversely and anteroposteriorly than in the *E. jacksoni*. The anterior border is continued as an alisphenoid angle which becomes prominent, and overhangs the foramen rotundum. The descending alisphenoid ridge commences within the anterior border of the foramen ovale. The pterygoid angle is anterior to the middle of the palatosphenoid wall of the nareal foramen, and in front of it the edge of the processus pyramidalis is marked by a shallow fossa or mark of insertion of the internal pterygoid muscle. The nareopalatal border is as far posterior to the line connecting the posterior edges of the maxillaries as the width of the second molar tooth. The palate is everywhere nearly flat. The malar bones spread well away from the maxillaries on each side, the anterior border of the zygomatic foramen being a segment of a circle. The squamosal part of the zygoma is more widely expanded than the malar part. In *E. jacksoni* the shape of the zygomatic foramen is quite different. Its anterior outline is interrupted by the projection of the maxillary bone posteriorly, which gives its anterior outline a bilobate form. It is longer than wide in that species, and wider than long in the *E. trigonocephalus*.

The infraorbital foramen is small. There are two lachrymal foramina; one larger, within the preorbital border, the other smaller, below the tuberosity on the rim of the orbit. The frontal foramina are separated by a space equal to one-fourth the entire frontal width. The supraorbital notches are wanting. The preorbital fossæ are well marked, are distinctly defined above, and extend as far as the anterior border of the lachrymal bone. The orbit is round, and looks upwards as well as outwards and

forwards, on account of the prominence of the zygomatic arch. There are two postparietal foramina, one below and behind, the other on the parieto-squamosal suture. The mastoid foramen is not small. The incisive foramina are large, are longer than wide, and are separated by a rather wide isthmus. The palatine foramina are opposite the third premolars. There is a foramen immediately below the postfrontal process. The optic foramen issues posterior to the line of the posterior border of the orbit, and in front of the anteroinferior angle of the alisphenoid. The foramen rotundum is large and round, and is immediately below and within the ridge above mentioned, and is not overhung by a transverse ridge of the same, as in the species of Meryeochœrus known to me. The f. rotundum doubtless includes the f. sphenoörbitale. The f. ovale is smaller and is separated by a considerable interval from the f. lacerum. The latter is subtriangular in form and is rather small, since the base of the otic bulla is in close sutural contact with the sphenoid and basioccipital for a considerable distance. The f. jugulare is subtriangular in outline and is smaller than the f. rotundum. It is entirely distinct from the f. condyloideum, which is the size of the f. ovale. No f. supraglenoideum. In comparing these foramina with those of the *E. jacksoni*, a general resemblance is to be seen. The frontal foramina in that species are *generally* closer together than in *E. trigonocephalus*, and the palatine foramen is *generally* opposite the fourth premolar instead of the third. The foramen magnum is slightly notched on its superior border in both.

The posterior outline of the nasal bones is truncate; it is more or less acuminate in all the specimens of *E. jacksoni* and *E. major* accessible to me. The prolongation of the frontal on either side of the nasals is also short and truncate in this species, and narrow and acuminate in the *E. jacksoni* and *E. major*. The lachrymal is deeper than long; in the species last named it is of variable size and form, but is usually as long as deep. There is no distinct ridge along the parieto-squamosal suture. The alisphenoid has a considerable contact with the pariëtal. The palatomaxillary suture is irregularly convex backwards on each side of the median line. It crosses the palate as in the *E. jacksoni*, at the front of the second maxillary tooth.

The teeth are much worn, and the first and last true molars with several of the premolars have been lost, indicating the age of the animal. The incisors are small and have round roots. The canines are large and of the usual form. The space between them and the first premolar is short. The fourth premolar is small. The second true molar is wider than long, and has no internal cingulum except between the lobes, and has a trace of anterior cingulum.

Measurements.	M.
Axial length from occipital condyles to premaxillary border	.187
Axial length from occipital condyles to postglenoid process	.031

Measurements.	M.
Axial length from occipital condyle to postfrontal process	.076
Axial length from occipital condyle to palatonareal border	.079
Axial length from occipital condyle to end of last molar	.091
Diameters of orbit { vertical	.031
Diameters of orbit { horizontal	.027
Depth malar bone at middle of orbit	.016
" zygomatic process posteriorly to glenoid face	.028
" skull (right angles to profile) at glenoid face	.045
" " " " orbit	.046
" " " " P-m. i	.030
Elevation of occiput from foramen magnum	.044
Width top of muzzle at preorbital fossæ	.040
" at middle of supraorbital border	.059
" " postfrontal process	.075
" " malar below orbit	.110
" " zygomatic process of squamosal	.145
" of occiput at condyles	.066
" " occipital condyles	.039
" " palate at palatonareal foramen	.028
" " " at M. ii	.032
" " " " canines	.030
Length of superior dental series with canines	.088
" " premolar series	.047
" " true molar series	.036
Diameters canine at base { anteroposterior	.009
Diameters canine at base { transverse	.010
Diameters P-m. iv. { anteroposterior	.009
Diameters P-m. iv. { transverse	.013
Diameters M. ii. { anteroposterior	.014
Diameters M. ii. { transverse	.018

The typical specimen of this species was found by Charles H. Sternberg on the North Fork of the John Day river. The horizon is probably somewhat different from that of the true John Day epoch.

Eucrotaphus jacksoni Leidy.

Proceedings Academy Philadelphia, 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contributions to Knowledge, 1852, p. 56, Plate VII, figs. 4–6. *Oreodon bullatus* Leidy, Extinct Mamm., Dakota and Nebraska, 1869, p. 106. Report U. S. Geol. Survey, Terrs. 1873, I, p. 318. *Oreodon occidentalis* Marsh, Amer. Journal Sci. Arts, 1873 (May), p. 409. *Eporeodon occidentalis* Marsh, Loc. cit., 1875, p. 250. *Eucrotaphus occidentalis* Cope, Bulletin U. S. Geol. Survey Terrs., V, p. 59.

Comparison of numbers of crania from the White river and John Day

formations fails to reveal any characters distinguishing them as more than one species. In fact the variation in various respects is greater among the individuals of the John Day epoch, than between those of the two epochs. This was by far the most abundant mammal of the John Day epoch while it appears to have been rare during that of the White River.

Specimens differ in the size of the preorbital fossa irrespective of other differences. In some specimens it is wide and profound, including the lachrymal bone; in others it is less extensive and is shallow, involving but part of the lachrymal. It is never wanting or obscure. For estimation of other characters, I select ten crania, nine from Oregon and one from Dakota, as expressing the greatest range of variation. Of these, three display a peculiarity in the form of the otic bulla. Instead of being contracted backwards in front, it is protuberant and full at its inferior anterior part. Five other crania, agreeing with these three in other respects, possess the normal form of bulla. In one cranium, which is rather more robust than the others, the infraorbital foramen is a little posterior to its usual position, being above the anterior part of the fourth premolar. This tooth is also distinctly smaller than in other specimens of otherwise similar dimensions. The majority of specimens range nearly alike in dimensions, but there are forms distinctly larger and smaller, which may represent distinct species. This question can be better decided when the skeletons are known. I give three sub-species which are defined as follows:

Length of cranium M. .197; of molar series M. .086; long diameter of base of paroccipital process transverse; its posterior base flat.. *E. j. jacksoni.*

Length of cranium M. .219; of molar series M. .091; paroccipital process as above.................................*E. j. pacificus.*

Length of cranium, M. .235; of molar series, M. .099; paroccipital process strongly compressed, its posterior base angulate on the middle line.........................*E. j. leptacanthus.*

The above measurements of length are made from the occipital condyles to the premaxillary border inclusive.

The three forms may represent good species. The *E. j. jacksoni* is of the size of the *Oreodon culbertsoni;* the *E. j. leptacanthus* is larger than the *E. major*, while the *E. j. pacificus* is intermediate between the two.

Eucrotaphus jacksoni jacksoni Leidy.

The typical specimen of the *Oreodon bullatus* Leidy agrees so nearly with the original type of *Eucrotaphus jacksoni*, that I cannot doubt their pertinence to the same species. There are two specimens in the collection of the Philadelphia Academy, besides the last named, and at least one in the museum at Princeton. A specimen from the John Day, Oregon, cannot be distinguished from these. It agrees with Marsh's measurements and description of his *Oreodon occidentalis*, and no doubt represents it. Its

identity with his *O. bullatus* has already been surmised by Leidy (Report U. S. Geol. Survey Terrs., I, p. 318).

Eucrotaphus jacksoni pacificus Cope.

This form is materially larger than the last named, equaling in dimensions and resembling in general form the *Eucrotaphus major* Leidy, of the White River beds. It is no doubt the form which has been identified under that name by Leidy in his report on John Day Fossils in the Report of the U. S. Geological Survey of the Territories, Vol. I. It is different from that animal in the form and position of the paroccipital process, as already pointed out. I have eight crania disengaged from the matrix which agree in dimensions and other characters assigned to this sub-species. In one of them the paroccipital process presents an approach to the form of that of the *E. j. leptacanthus.* A specimen from the White Buttes of Central Dakota agrees with those from Oregon in all the essential characters, and is the second one of the sub-species I have seen which is not Oregonian. I have many crania of this sub-species not yet entirely cleared of matrix.

From John Day river and Crooked river, Oregon ; C. H. Sternberg and J. L. Wortman ; White river of Nebraska. Mus. Princeton.

Eucrotaphus jacksoni leptacanthus Cope.

This is the largest form of the genus, exceeding the typical *E. major* in the length of the skull by 28 mm. It is thus far represented in my collection by two very perfect crania. There is considerable reason for anticipating that this form will turn out to be a valid species. Besides the peculiar form of the paroccipital processes, the typical specimen presents the following characters :

The frontal region is flatter than in the two other sub-species, and is concave on the median line in transverse section. This concavity is probably partly abnormal. The profile of the sagittal crest instead of presenting a gently convex outline, is concave, rising posteriorly. The lateral occipital crests instead of being angulate are truncate behind, and the inferior angle projects much beyond the vertical line of the occipital condyles. As this part is broken off in most of my specimens of the *E. j. pacificus,* I cannot decide as to its value. The inferior carina of the tympanic bone extends forwards to contact with the internal extremity of the postglenoid process. It does the same in the Oregon specimen of *E. j. jacksoni,* and in the Dakota specimen of the *E. j. pacificus.* In two of the latter, from Oregon, where the part is cleaned, the keel does not extend so far forwards or inwards.

The typical specimen is from the John Day beds of John Day river, Oregon, and was found by Jacob L. Wortman.

Eucrotaphus major Leidy.

Oreodon major Leidy, Ancient Fauna of Nebraska, 1853, p. 55, Pl. IV, fig. 6. Proceedings Academy Philadelphia, 1853, 398 ; 1856, 164 ; 1857, 89.

Extinct Mammalia, Dakota and Nebraska, 1869, p. 99, Pl. VII, fig. 1; VIII. *Eporeodon major* Marsh, Am. Journ. Sci. Arts, 1875, p. 250.

I find this species to differ in the external position of the paroccipital process, as related to the otic bulla, from the *E. jacksoni*. I might add that it differs in dimensions from all excepting the *E. jacksoni pacificus*. In the *E. jacksoni* the base of the paroccipital process is in the same line as the interior base of the otic bulla. In the Oregon form of the *E. major* the base of the paroccipital process is much flattened, so as to be transverse, and its internal border is on the external side of the extremity of the large swollen bulla. This species differs also from the *E. jacksoni* in the median vertical carina of the occipital bone above the foramen magnum, a region which is in the *E. jacksoni* broadly flattened. Besides these points I do not notice any divergence from the *E. jacksoni*, with which it agrees in the various characters in which the latter differs from the *E. trigonocephalus*.

The Nebraska and Oregon forms do not agree in all respects. Thus, while the dimensions of the dental series are the same in both, the frontal region is more elongate in the Oregon animal, giving greater length to the skull. The third superior premolar has a somewhat different form in the two. They may then be characterized as follows:

Dental series M. .125; skull .224; third superior premolar, subtriangular..*E. m. major*.

Dental series M. .125; skull .240; third superior premolar subquadrate..*E. m. longifrons*.

Eucrotaphus major major Leidy.

Known only as yet from the White River epoch of Nebraska and Dakota.

Eucrotaphus major longifrons Cope.

Known from a single skull from the North Fork of the John Day river. Oregon, found by Charles H. Sternberg. It may be observed here that the Oreodontidæ of this locality are mostly distinct from the species of the John Day river proper.

MERYCOCHŒRUS Leidy.

Report U. S. Geol. Survey Terrs., I, 1873, p. 202. Bettany, Quart. Journ. Geol. Soc. London, 1876, p. 262; Cope, American Naturalist. 1884. p. 281. Leidy, Extinct Mammalia of Dakota and Nebraska, 1869, p. 110 (nomen nudum). Proceedings Academy Philadelphia, 1858, p. 24 (nomen nudum).

As indicated in the analytical table at the head of this article, I can only distinguish this genus from *Eucrotaphus* by the confluence of the premaxillary bones. The position of the external infraorbital foramen cannot be regarded as furnishing generic characters, especially as it displays considerable variation and gradation. Some of the species are in this respect quite identical with species of Merychyus (*M. superbus*), while others

possess the widely different position ascribed to this genus by Leidy. Few if any of the characters given by Mr. Bettany as those of the genus, can be regarded as other than characters common to several of its species. Perhaps the most important of these is the angle formed by the basifacial with the basicranial axis, by which the face is presented as much forwards as upwards. The species present considerable variety in form. The genus embraces the largest species of the family, such as *M. macrostegus*, *M. superbus*, etc. The characters of the species are as follows :

I. Foramen infraorbitale above middle of fourth superior premolar ; posterior part of zygoma expanded ; palate moderately produced posteriorly.

Squamosal part of zygoma less expanded anteriorly and with rounded border ; head elongated ; premaxillary bone not produced ; otic bulla larger, compressed, extending anterior to postglenoid process ; size large .... *M. superbus*.

Head shortened occipitally, so that a line drawn through postglenoid and paroccipital processes makes 90° with the middle line ; malar bone openly grooved below orbit ; angle of mandible obliquely truncate. .... *M. leidyi*.

Squamosal part of zygoma most expanded in front, and elevated behind, so that the cranium is as wide as from the paroccipital process to the canine tooth ; its posterior angle rising to a level with the sagittal crest ; its inferior edge spread outwards ; its superior edge truncated ; occiput not shortened ; malar flat below orbit ; postglenoid process marking front of bulla.. *M. chelydra*.

II. Foramen infraorbitale above the first true molar. Palate greatly produced posteriorly.

Squamosal part of zygoma much expanded, and with truncate edge ; malar bone robust, prominent ; skull, width equal length from condyles to first premolar ; maxillary produced anteriorly ; frontal plane, transverse diamond-shaped ; bulla small, conical, posterior to anterior edge of postglenoid process.. *M. macrostegus*.

Squamosal part of zygoma little expanded upwards or laterally, edge rounded ; malar bone flat ; bulla large, extending in front of postglenoid process ; front longitudinally diamond-shaped, decurved at orbit.................... *M. montanus*.

III. Foramen infraorbitale above anterior border of second true molar.

Zygoma originating above second molar ; large ; incisors small (fide Leidy). .... *M. rusticus*.

Zygoma originating above third true molar ; larger ; incisors large (fide Leidy)..................................... *M. proprius*.

Of the above seven species, four are represented in my collection, some of them by a large amount of material. The latter are from the John

Day and Ticholeptus Miocene horizons. The *M. rusticus* of Leidy is only known to me from the descriptions of that author. It is from the Sweetwater river, Wyoming, from a bed of probably Ticholeptus age. The *M. proprius* Leidy, also unknown to me by autopsy, is from the head of the Niobrara river, Nebraska, from a bed said by Hayden to be intermediate between the Oreodon or White River and Procamelus, or Loup Fork horizons, and therefore probably of Ticholeptus age also. The *M. leidyi* I only know from the description of Mr. Bettany. It is from the John Day beds. Mr. Bettany also describes an *M. temporalis*, which I cannot distinguish from the *M. superbus* Leidy.

Merycochœrus superbus Leidy.

Oreodon superbus Leidy, Proceedings Academy Philadelphia, 1870, p. 109. Extinct Mam. fauna, Dakota and Nebraska, 1869, p. 211; Plate I, fig. 1; II, fig. 16; VII, figs. 7–11. *M. temporalis* Bettany, Quar. Journ. Geol. Soc., London, 1876, xxii, p. 269; Pl. XVII.

Of this fine species I have nine crania extracted from the matrix, and a good many not yet cleaned. As the specimen described by Leidy is in a very imperfect condition, the characters of the species, and even its generic position, have remained hitherto very obscure.

As compared with the allied species, the *M. superbus* is slightly exceeded in size by the *M. macrostegus* and *M. montanus*. Its posterior zygomatic expansion is less pronounced than in the *M. macrostegus* and *M. chelydra*, and its border is rounded, even when, as is sometimes the case, it is greatly thickened. In the first and last named of the above species, its border is separated by a distinct angle from both the internal and external faces, forming thus a distinct truncate face which looks upwards. The otic bulla is larger than in the two species mentioned, and extends anterior to the postglenoid process. The nareal fissure extends well down towards the alveolar border of the premaxillaries, which are therefore more extensively separated than Leidy represents to be the case in the *M. rusticus*. The external face of the malar bone below the orbits is flat. The anterior extremity of the zygomatic process is not so prominent as in *M. chelydra*, and is rounded instead of being flared out below, as in that species. The greatest width of the skull is at the glenoid surfaces, and not anterior to them, as in *M. chelydra*. In only one of seven crania, where the parts are preserved, does the posterior squamosal angle rise as high as the sagittal crest.

I cannot detect any difference between the specimen described by Mr. Bettany as the type of his *M. temporalis*, and those of the *M. superbus* in my possession. The shallowness of the preorbital fossa described by Mr. Bettany is repeated in one of my crania, and its depth is very variable in the others. As regards the *M. leidyi* of Bettany, I have none exactly like it, although the type specimen does not differ much from the *M. superbus*, to judge from the figure and description given in the Quarterly Journal of the Geological Society, 1876, p. 270. The two distinctive

characters, which appear most tangible among those mentioned by Mr. Bettany, the shortness of the occipital region, as measured by the angle made by a line drawn through the postglenoid and paroccipital processes, with the middle line, and second, the grooved character of the sub-orbital part of the malar bone, are not found in any of my specimens of *M. superbus*. The anterior extremity of the squamosal process of the zygoma is protuberant in one of them, as in the *M. leidyi*. Another character is suggested by Mr. Bettany's figure, but is not mentioned in the text. The angular border of the mandibular ramus extends obliquely forwards instead of being prominently convex as in the best preserved entire mandible of the *M. superbus* in my possession. Nevertheless in another specimen, where a good deal of the posterior border is preserved, the outline is nearly as oblique as in the *M. leidyi*. The species, however, is distinct so far as now known.

John Day epoch, Oregon, C. H. Sternberg and J. L. Wortman. Localities, John Day river, Bridge creek, and Camp creek of Crooked river.

Merycochœrus leidyi Bettany.

Quarterly Journal of the Geological Society of London, xxxi, 1875, p. 270; Plate XVIII.

Defined and discussed under the preceding species.

John Day epoch, Oregon; Lord Walsingham. John Day river.

Merycochœrus chelydra, sp. nov.

This species is known to me by a skull without mandible, which is entire, except that the extremity of the nasals and the border of the pre-maxillary bones are broken off. It is unfortunate that I have no second skull to confirm its characters, but my numerous specimens of the *M. superbus*, to which it is most nearly allied, do not present any approximations which suggest transitions between the two.

The striking character of this cranium is its great breadth at the temporal region, as compared with its length and other dimensions. The forms of the otic bulla differ from those of the *M. superbus*. One method of expressing the width of the skull is as follows. The point of the frontal bone which is equidistant from the supraoccipital notch and the external edge of the zygomatic arch, measured in a horizontal plane, is directly above the posterior or nareal palatal border, when the skull rests on the teeth. In the *M. superbus*, in the most robust examples, this point is above a point which is a good deal nearer to the line of the anterior edge of the glenoid surfaces than to the palatal border, and at least 30mm. posterior to the latter. That this relative shortness of the basicranial axis is not due to a shortening posterior to the glenoid surfaces, as is the case in *M. leidyi* Bett., is proven by the fact that a line drawn through the postglenoid and paroccipital process makes an angle of 90° with the middle line, as in *M. superbus*.

The muzzle is compressed and its superior surface is regularly rounded

The side is divided by the gentle convexity continued forwards from the malar region. Below this and above the premolars the face is concave. Above it the preorbital fossa is well marked, though not deep, and gradually fades out anteriorly. The interorbital region is flat, as in *M. macrostegus*, and the supraorbital border is not decurved, as it is in *M. superbus* and *M. montanus*. The supraorbital and preorbital borders of the front are, however, not continuous as in *M. macrostegus*, though nearly in the same line, which they are not in *M. superbus*. The orbits are more oblique than in *M. superbus*, looking more upwards and forwards, and their vertical exceeds their transverse diameter. The malar bone though oblique, is more vertical than the orbit below the latter, and has an uninterrupted gently concave surface. The postorbital bridge is narrow, and consists one-half of the malar and one-half of the frontal bones. The inferior edge of the malar is thin and is slightly convex downwards, and passes behind the protuberant squamosal at a point behind the line of the postfrontal process. The anterior extremity of the squamosal is not protuberant below the orbit and only begins to rise gradually below the line of the postfrontal process. It then expands rapidly downwards and outwards in a strong curve, with its flat surface looking upwards as much as outwards. After making a short downward turn it rises steeply, contracting gradually inwards, and presenting a convexity posteriorly, with its truncate edge looking outwards. Its apex is nearly on a level with the sagittal crest. The inner or descending edge of this process is concave, so that the apex overhangs a little the posterior outlet of the temporal fossa. The anterior temporal angles are strongly marked and unite into a sagittal crest. The edge of the crest is thickened, so that its section is a letter T.

The supraoccipital bone presents a wide flat convexity above the foramen magnum, in distinction from the stronger convexity of *M. superbus*, and the still stronger of the *M. macrostegus* and *M. montanus*. As in the other species, the posttemporal (= lateral occipital) crests are only present at the upper half of the occiput. Between them there are two ligamentous or tendinous insertions, but no median keel. The exoccipital and posttympanic borders form a tuberosity below the meatus auditorius, which passes upwards into a short convex posttemporal crest. The paroccipital process nearly reaches the postglenoid by its anterior external edge. The tympanic is complete, is not keeled below, and extends itself as a lamina over the posterior side of the postglenoid process. The section of the basioccipital is open V-shaped. The inferior flat surface of the sphenoid is produced backwards in a wedge-shaped prominence to a line connecting the anterior edges of the paroccipital processes. It has the same form in *M. macrostegus*, but in three skulls of *M. superbus*, where it is visible, the apex of the wedge does not extend posterior to the middle of the otic bullæ. The bullæ are small and subconical, and reach as far as the anterior edge of the postglenoid process. In the latter the transverse diameter exceeds the anteroposterior, which exceeds the vertical diameter. This process and the otic bulla are of about equal protuberance. In four

crania of the *M. superbus*, where both are well preserved and exposed, the bulla is considerably more prominent than the postglenoid process. The glenoid surface is well-defined and equally wide at both extremities. The inferiorly presented surface of the zygomatic arch, is wider than in any of the other species, including examples of *M. superbus* of superior dimensions in other respects. The surface is rugose. The length from a line connecting the median external columns of the last superior molar, to the posterior nareal border, enters three times into the distance from the latter to the border of the foramen magnum. In *M. superbus* it goes three to three and a half times; in *M. macrostegus* and *M. montanus* once only. Behind the molars the produced palatal roof is more concave than between the last two true molars. The palate becomes then more concave (convex), and between the first premolars and canines becomes flat, and expands laterally. The nareal fissure is not much contracted between the premaxilliaries.

The infraorbital foramen is above the anterior half of the superior fourth premolar, and is of moderate size. The frontal foramina are separated by a space which is less than half as wide as that which separates each one from the superciliary border. There is no supraorbital notch. The incisive foramina are large, are wider than long, and approach close to the bases of the canine teeth. The palatine foramina are minute or obsolete. The foramen ovale is isolated and is opposite the junction of the glenoid and postglenoid surfaces. The jugular foramen is isolated by the extensive contact of the otic bulla and the basicranial axis. Perhaps the condyloid foramen is included in it, as I do not find it in the usual position. The animal is so old that no sutures are visible.

The teeth are not all cleared from the matrix, which is hard and brittle. The first true molar is much worn. The first premolar is two-rooted, and is separated from the canine by a diastema equal in length to the long diameter of its crown.

Measurements.	M.
Length from occipital condyle to front of canine tooth.	.300
" " " " " postglenoid process...	.041
" " " " " postfrontal process...	.132
" " " " " palatonareal border..	.118
" " " " " end of last molar.....	.146
Diameters of orbit { vertical	.0455
Diameters of orbit { transverse	.039
Depth of malar bone at middle of orbit	.034
" " zygomatic process to glenoid face behind.....	.088
Width of top of muzzle at preorbital fossa	.043
" at middle of supraorbital border	.094
" " malar below orbit	.160
" " middle of zygomatic arch	.254
" of occiput at superior crests	050

Measurements.	M.
Elevation of occiput from foramen	.084
Width of occipital condyles	.068
Width of occiput at condyles	.095
Depth of skull at right angles to profile at glenoid face.	.095
" " " " " " orbit	.087
" " " " " " P-m 1	.075
Length of superior dental series with canine	.159
" " premolar series	.061
" " true molar series	.065
Diameters M. i { anteroposterior	.0180
transverse	.0185
Diameters of canine { anteroposterior	.016
transverse	.020
Diameters P-m. ii { anteroposterior	.0155
transverse	.090
Width of palate at m. i	.044
" " P-m. i	.057

The typical specimen was found on the John Day river, Oregon, by Mr. J. L. Wortman.

Merycochœrus macrostegus, sp. nov.

I have been able to discover in my collection as yet, but one cranium with entire mandible of this species. The very marked characters of this skull are such that no farther evidence of its reference to a peculiar species is needed. Its affinities, as expressed in the analytical key which accompanies the general discussion of this genus, are with the *M. montanus*. This is shown in the posterior positions of the infraorbital foramen, and of the posterior nares. As peculiar characters may be added the form of the frontal plane and of the otic bulla; also the prolongation of both the premaxillary and supraoccipital regions, and the forms of the zygoma, the angle of the mandible, and the first inferior premolar tooth. The skull reaches a greater length than that of any species, excepting the *M. montanus*, but is not nearly so robust as in the *M. chelydra*, resembling in this respect rather the *M. superbus*.

The muzzle is compressed, and there is a decided concavity just above the second premolar, above which the surface is a little convex. Above the infraorbital foramen, the face is abruptly convex, the convexity sloping upwards to the base of the median ridge formed by the convex nasal bones. Behind this the side of the face is a plane which slopes outwards as it descends, which is only interrupted by the rather small, but well defined, preorbital fossa. The fossa is better defined in front than in the other species, but I do not know whether the character is constant. The front is a transverse diamond-shaped area, bounded posteriorly by the anterior temporal ridges, and anteriorly by the lines of the supraorbital borders

produced to their point of intersection with each other. Such point of intersection is above the second true molar in this species; in *M. superbus* and *M. chelydra* it is above the posterior part of the second premolar. The area in these species enclosed by the lines in question is half as long again as wide, instead of wider than long by 18mm. This difference is partly caused by the greater prominence and flatness of the postorbital angle of the frontal bone in the *M. macrostegus*, and the more anterior direction of the orbits, which I may add have none of the tendency to superior direction seen in *M. chelydra*. The wide triangular area thus enclosed on its external sides by the orbit and anterior temporal ridges, is perfectly flat. Such an area can hardly be defined in the other species, and the surface there is rounded and descending. The malar bone is deep, flat and a little oblique outwards, and the rim of the orbit projects a little, giving it a slight concavity. The orbit is deeper than wide. The anterior part of the zygomatic process of the squamosal is not protuberant below the orbit, but gradually rises outwards posteriorly, attaining its greatest expansion opposite the middle of the zygomatic foramen; above, its course is for a time parallel with the middle line of the skull. The form of the zygomatic arch is more like that of *M. chelydra* than any other species, but it is not so much expanded, especially anteriorly. Its inferior and posterior surface is, however, widened, making an angle with the external or marginal surface, which is in turn separated by an angle from the superior and anterior surface; at the middle of the arch the superior surface has a width of 19mm., and the external a width of 23mm. The posterior angle rises to the plane of the summit of the sagittal crest, and the apex, which is less than a right angle, stands above the external base of the postglenoid process. The preglenoid border is not exactly at right angles with the middle line, but makes a slight angle outwards and forwards. The long diameter of the zygomatic foramen is parallel with it. The ridge along the parietosquamosal suture is insignificent. The supraoccipital region is very prominent, and as in the other species of this genus is narrowed below by the disappearance of the posterior temporal or exoccipital crests. They are continued downwards and disappear, leaving a wide convex surface above the foramen magnum. This is separated by the usual lateral fossa from the posterior temporal angles.

The coössified mastoid and paroccipital processes much contract the auricular fossa below, but do not close it. The latter is contracted at the base of its terminal part, and is distally slender. The otic bulla is the smallest known in the genus. It is compressed and oval, and not produced beyond the postglenoid processes either forwards, backwards or downwards, in this differing much from the *M. montanus*. It is separated by wide and equal intervals from this process, the glenoid surface, and the basisphenoid. It sends a process backwards and inwards to a sutural junction with the basioccipital bone. The tympanic bone is flat below, and is united with the posterior base of the squamosal by a flat expansion. The postglenoid process is robust, and has the height and thickness equal,

while the width exceeds both. The basioccipital bone is prominently keeled on the middle line, so that the section is a V of a more compressed character than the section of the same in *M. superbus*. The median plane of the sphenoid is prominent, and is continued as a wedge with the apex opposite the posterior borders of the otic bullæ. The palatine borders are parallel, except where they form on each side an open angle at the junction of the descending process of the sphenoid, which is here directed forwards. Its external border is distinct from that of the palatopterygoid plate, and makes a groove with it. The maxillary bone is not produced posterior to the notch on either side of the base of the posterior production of the palatine bones. The middle line of the latter is deeply concave opposite the former, and the palate is also especially concave between the first true molars. The palate is flat between the first and second premolars. The inferior surface of the squamosal process of the zygoma is roughened for the origin of the masseter muscle. The inferior edge of the malar comes from its inner side, and is narrow and with a median groove. Its inferior edge is continued as a ridge of the maxillary as far as opposite the anterior lobe of the second true molar. The maxillary bones are more produced anteriorly than in any of the other species. The apex of the nasal bones stands above the posterior border of the canine in this species; above the anterior edge in *M. superbus*, *M. chelydra* and *M. leidyi* (fide Bettany). The posterior border of the nares is above the anterior part of the first premolar in the three species named, except *M. chelydra* where it is over the posterior edge of the canine: in *M. macrostegus* it is above the posterior edge of the longer first premolar.

The infraorbital foramen is large, and its posterior border is above the anterior root of the first true molar. The incisive foramina are large, and each one is a little longer than wide. The nareal opening contracts gradually to its inferior apex. There is a considerable maxillary foramen opposite the middle of the fourth superior premolars. The posterior nareal is not large; its anterior outline is regularly concave. Its lateral (sphenoid) borders reach to opposite the anterior faces of the postglenoid processes and bound the foramen ovale on the inner side. The latter is round, is rather small, and is opposite the middle of the postglenoid surfaces. The foramen rotundum on the other hand is large and vertically oval, and is bounded below by a transverse prominence of the base of the alisphenoid bone. It probably includes the sphenoörbital foramen, a foramen anterior to its inferior border probably communicating with the nareal chamber. The optic foramen is small, and is situated opposite the anterior two-fifths of the zygomatic fossa and a little above the line of the apex of the foramen ovale. The foramen lacerum is ovoid and not large. The posterior foramen lacerum is a transverse sigmoid, one extremity being the jugular foramen. The mastoid and postpariëtal foramina are of moderate and equal sizes. No postsquamosal or supra- or postglenoid foramina.

The animal described is too old to exhibit sutures.

The mandible possesses some distinctive characters. The angular border is not prominent posteriorly, extends forwards below, and projects below the general level of the inferior border of the ramus. Neither of these characters is observable in the only ramus of the *M. superbus* in which the lower part of this border is well preserved, but in some others of that species the superior part of the border is much as in *M. macrostegus*. The inferior edge of the ramus is straight, but there is a descending tuberosity of the symphysis which may be an individual peculiarity. The symphysis is very concave in profile, and the incisive border is produced in accordance with the prolonged muzzle. In the *M. superbus* it is sometimes convex, sometimes a little concave, but not so much so as in this jaw. The coronoid processes are small and slightly everted. The inner ridge of its anterior base is more prominent than the exterior, and encloses a fossa with it. The masseteric fossa is not noticeable. There is one large mental foramen below the third premolar. The dental foramen is large and oval, and when the mandible stands on a level surface is opposite the middle lobe of the third inferior molar tooth.

In dentition this species is distinguished by the relatively large size of the premolar teeth, of which the first, second and third are two-rooted in both jaws. Both the first and second in the upper jaw have short diastemata anterior and posterior to them, the largest being behind the canine tooth, and nearly as long as the premolar's crown. All the teeth are a good deal worn in the specimen. One can see two internal cingula inclosing fossæ on the third premolar. The true molars increase in size rapidly posteriorly and the third has a well-developed external heel. The molars have no internal cingula; these are present in five of seven skulls of the *M. superbus* where these parts are cleaned. The most noteworthy point in the mandibular dentition is a very rudimental character of the internal vertical ridge of the crown of the first premolar. The posterior fossa of the fourth premolar is closed, and the anterior remains open, on wearing. In *M. superbus* both are closed in the specimen where visible. The anterior inner wall is represented in the second and third premolars by a cingulum. No cingula on the true molars. First premolar very robust, its section lenticular.

Measurements.	M.
Axial length from occipital condyles* to premaxillary border	.345
Axial length from occipital condyles to postglenoid process	.045
Axial length from occipital condyles to postfrontal process	.138
Axial length from occipital condyles to palatonareal border	.100

*The occipital condyles are broken off in the specimen, so I measure from the superior border of the foramen magnum, which is, in the other species, in the vertical line of the occipital condyles.

Measurements.	M.
Axial length from occipital condyles to end of last molar	.058
Diameters of orbit { vertical	044
Diameters of orbit { transverse	.036
Depth malar bone at middle of orbit	.037
" zygomatic process to glenoid face behind	077
" skull (right angles to profile) at glenoid face	.088
" " " " " " orbit	088
" " " " " " P-m i	.068
Elevation of occiput from foramen magnum	.064
Width top of muzzle at preorbital fossa	.038
" at middle supraorbital border	.109
" " postfrontal process	137
" " malar below orbit	166
" " middle of zygomatic arch	.243
" of occiput at superior crests	.050
" " " condyles	101
Length superior dental series, with canine	.177
" " premolar series	092
" " true molar series	068
Diameters canine { anteroposterior	.013
Diameters canine { transverse	.018
Diameters P-m. i { anteroposterior	017
Diameters P-m. i { transverse	.075
Diameters m. i { anteroposterior	019
Diameters m. i { transverse	.0215
Diameters m. iii { anteroposterior	.038
Diameters m. iii { transverse (at middle column)	029
Width of palate at P-m. i	.061
" " m. i	.053
" " middle of zygomatic arch	047
Length of inferior dental series with canine	179
" " premolar series	.088
" " true molar series	.088
" of ramus to posterior edge	.279
Depth of ramus mandibuli at condyle	.124
" " " m. iii posteriorly	.078
" " " m. i posteriorly	.048
" " " P-m. i (front)	.015
Diameters inferior P m i { anteroposterior	.019
Diameters inferior P m i { transverse	.0125
Diameters " P-m iv { anteroposterior	.021
Diameters " P-m iv { transverse	01.
Diameters " m. i { anteroposterior	[illegible]
Diameters " m. i { transverse	[illegible]

Measurements. M.

Diameters inferior m. iii	anteroposterior	.044
	transverse	.018

This fine species is from the John Day epoch of the Miocene. The typical specimen was found by my assistant, Charles H. Sternberg, on Bridge creek, Oregon. Much credit is due Mr. Sternberg for his unwearied exertions in the cause of science, which have been continued through many occasions of risk and discomfort.

Merycochœrus montanus, sp. nov.

This large animal is represented in my collection by a nearly entire skull with parts of both mandibular rami complete. Rami of another individual give the entire dentition of the lower jaw except the incisors. A third individual is represented by a symphysis with premolars, canines and incisors, and by various parts of the skeleton, including feet. Of the cranium mentioned, the muzzle to the preorbital fossa and the palate to the first true molar are wanting. The region of the larmier is lost, but the general resemblance of the species to the *M. macrostegus* in other respects, leads me to suspect that it is absent, and that the *M. montanus*, is rightly referred to the genus Merycochœrus. This course is indicated by the structure of the superior molar teeth, which have the character of those of this genus, rather than that found in Merychyus. That is, the posterior internal crescent sends its anterior horn to the external wall of the crown, thus cutting off the posterior horn of the anterior crescent. Dr. Leidy has shown that the reverse is the case in the *Merychyus major;* that is that the posterior horn of the anterior crescent reaches the external wall of the crown, cutting off the anterior horn of the posterior crescent. I have observed that this is also the case in the other species of Merychyus which have come under my notice.

The posterior position of the infraorbital foramen and the greatly produced palate distinguish this species from those of the John Day epoch, excepting the *M. macrostegus*, while in the *M. rusticus* and *M. proprius*, the infraorbital foramen is still further posterior. The palate of these species is unfortunately unknown.

The part of the maxillary bone posterior to the infraorbital foramen is nearly flat, and the proximal part of the malar bone is also flat. The inferior edge of the latter is narrow and is marked by a groove which terminates anteriorly in a shallow fossa. The ridge continuous with this edge terminates above the anterior lobe of the second true molar. The zygoma as far as the anterior border of the glenoid cavity is slender, and not convex, but flat in every direction, nor is it decurved as in *M. superbus*. The zygomatic foramen is relatively much smaller than in that species. Its posterior or preglenoid boundary is not at right angles to the sagittal crest as in that species, but is oblique outwards and forwards at an open angle. The obtuse median edge of the zygoma looks upwards, not outwards as it does in *M. superbus* and *M. macrostegus*, and the superior expansion is

opposite the internal extremity of the glenoid face, instead of the external as in *M. superbus*, or the middle, as in *M macrostegus*. The border descending to the supraauricular crest is thin and vertical in direction and the superior angle stands above the middle of the postglenoid process not external to it, as in the two species above named. The postglenoid process is robust and has a convex posterior face The paroccipital process is long and acuminate. An external truncate ridge on the front of its base partially embraces the meatus auditorius, and curving forwards becomes the anterior edge of the process, which is separated from the postglenoid by but a narrow interval The tympanic bone forms a tube more distinct from the surrounding regions than in the other species here described, and has a longitudinal inferior keel, which is not visible in the *M. superbus* and *M. macrostegus* It is separated at the meatus by but a short interval from the base of the postglenoid process The supraauricular and mastoid crests unite and form a short acute crest, which does not continue into a prominent posttemporal, but descends into a mere angle, which continues as a fine line to the convexity of the true posttemporal crest above The latter arises from the bifurcation of the sagittal crest, and after a strong convexity descends with its fellow to a narrow prominent convex ridge, which rises from the foramen magnum. Thus the occiput on either side of this prominent middle line is deeply excavated, and the fossa is bounded on each side and anteriorly by the low posttemporal angle, and the more prominent mastoid ridge There is no median keel. The median ridge of the occiput is more prominent and not so flat as in *M. superbus*, but is more as in *M macrostegus*. The sagittal crest is well developed, and has a straight superior border, which is not thickened as in *M. chelydra*. The anterior temporal ridges are represented by an angle which is nearly right. The superior squamosal suture is marked by a prominent ridge The front is gently convex transversely, and the supraorbital border is more strongly decurved than in *M. superbus*, which are more so than in *M macrostegus*

The basicranial axis makes a strong angle with the basifacial as in the other species of the genus, showing that the face was presented obliquely forwards, as in the peccary The section of the basioccipital bone between the paroccipital processes is V shaped, owing to the presence of a strong median angle. In *M. macrostegus* this bone is similar, but in *M. superbus* it is much flatter, and there is a weak median keel The sphenoid is in line with the occipital and has a broadly rounded-truncate inferior face The otic bullæ are large and compressed They extend from the middle of the base of the paroccipital process to considerably in advance of the postglenoid process, and approach very near to the glenoid surface. The interval which separates them is small, equaling one fifth the anteroposterior diameter of the bulla. This is very different from the *M. macrostegus*, where the space between the glenoid surface and the bulla, is equal to the anteroposterior diameter of the latter near the middle As already pointed out, this species agrees with the species just named in the

great prolongation of the palatal floor of the nareal cavities. The distance from the foramen magnum to the nareal border equals the distance from the latter to the line connecting the median external vertical crests of the last superior molars. In *M. superbus* the former measurement is two and one-half times as great as the latter.

The mandible shows the nearer relationship to the *M. macrostegus* than to the *M. superbus*, in the anterior elongation and greater relative size of the premolar teeth. It agrees with the former in having the profile of the symphysis concave, and not convex as in *M. superbus*. It is less concave in my single specimen than in that of *M. macrostegus*. The position of the posterior extremity of the symphysis is below the middle of the third inferior premolar. The coronoid process is low, and of small size. Its compressed convex apex is directed at an angle of 45° from the middle line outwards and forwards. Its anterior face soon widens out and the internal edge becomes much more prominent than the external, with which it encloses a shallow, subtriangular, subvertical fossa. The external border is continuous with the external alveolar border. The masseteric fossa is small and has no distinct inferior border, and does not descend below the level of the line of the middle molar teeth. The inferior border of the ramus is nearly straight. The inferior incisive alveolar border is much more strongly convex than in the *M. superbus*. The condyle has the posterior articular face on the inner side, as in other species.

The infraorbital foramen is large and is above the anterior part of the first true molar tooth. The meatus auditorius is small. There are two postparietal foramina on the pariëtosquamosal suture. No supraglenoid or postglenoid foramina. There are two mental foramina, one not small below the anterior part of the first true molar, the other, quite large, below the posterior part of the third premolar. The dental foramen is situated on a level with the alveolar border and well posteriorly, its anterior border being a little in front of a line dropped vertically from the apex of the coronoid process. It is thus similar in position to that of *M. macrostegus* and different from that of *M. superbus*, where it is above the line of the apices of the molars, and is posterior to the line dropped from the apex of the coronoid.

In the superior true molars, the size increases rapidly posteriorly. The third is relatively of more elongate form than the first, but the posterior external column is but little produced. The other vertical ridges are quite prominent. The external faces of the external lobes are nearly flat. Besides the relation of the adjacent horns of the internal crescents already mentioned, the posterior horn of the posterior crescent in the first and second molars is cut off from the external wall of its own crown by the anterior horn of the anterior crescent of the crown next posterior. This does not exist in worn molars of *M. superbus* and *M. macrostegus*, but is observable in little worn teeth of the former. It does not look as though the character would disappear with wear in the *M. montanus*. The only

trace of cingulum on the superior molars is on the inner base of the anterior lobe, where it is weak, and in the interspace between the internal lobes, where it is a narrow tubercle. Enamel obsoletely vertically striate. It is wanting on the external side of the internal crescent, as Leidy has shown to be the case in certain species of Merychyus. The fifth lobe of the last inferior molar is well developed and has its two crescents separated by a groove. The adjacent horns of the external crescents are of about equal length. No cingula, except a trace on front and rear of crowns, and a tubercle between the bases of the external lobes. The fourth premolar has two fossæ isolated, one anterior to and the other posterior to the principal apex, which is double, and anterior to the middle. Before wear, each of these fossæ opens inwards. The crown of the third premolar has its inner face unequally divided by a crest behind the middle. Posterior to this the space is occupied on the inner side by two shallow fossæ of which the posterior is the narrower. Anterior part of inner face of crown concave. One principal angular cusp. The second premolar has a compressed triangular crown with a long base, and a weak vertical ridge on the internal side. The first premolar is a very robust tooth with a straight posterior border directed at 95° forwards, and is vertically truncate in the specimen by friction with the canine. Section of crown lenticular, rounded in front.

Measurements.	M.
No. 1.	
Length from occipital condyle to postglenoid process	.049
" " " " " postfrontal process	.135
Width of occiput at posttemporal crests	.054
" " " condyles	.102
Elevation of occiput above foramen magnum	.084
Length from foramen magnum to palatal border	.060
Width between apices of otic bullæ	.042
Length from inferior m. iii to apex of coronoid process	.075
" of superior true molar series	.084
Diameters m. i { anteroposterior	.026
Diameters m. i { transverse (at middle rib)	.025
Diameters m. iii { anteroposterior	.034
Diameters m. iii { transverse (at middle rib)	.025
Length of inferior true molar series	.065
Diameters P-m. iv { anteroposterior	.0205
Diameters P-m. iv { transverse behind	.015
Diameters m. i { anteroposterior	.022
Diameters m. i { transverse	.016
Diameters m. iii { anteroposterior	.040
Diameters m. iii { transverse	.033
No. 2.	
Length of ramus mandibuli from incisive border to condyle (oblique)	.280

Measurements.	M.
Length of dental series (straight line)	.191
" from last molar to apex of coronoid	.0735
" of premolar series	.085
" " true molar series	.084
" " second premolar on base	.021
" " first premolar on base	.0225
Depth of ramus at coronoid	.044
" " " end of m. iii	.073
" " " middle m. i.	.056
" " " P-m. i. vertically	.034

The specimens of this species were found by Mr. J. C. Isaac in the Ticholeptus beds of Deep river, Montana, during his Expedition of 1880.

Merycochœrus rusticus Leidy.

Report U. S. Geological Survey Terrs., 1873, i, p. 199, Pl. III, figs. 1–3; VII, figs. 1–5; XX, figs. 9–31. Proceedings Academy Philadelphia, 1870, 109.

The smallest species, characterized among other things by the closure of that part of the nareal fissure which separates the premaxillary bones below. According to Leidy's figure above quoted, the depth of the middle line of the undivided premaxillary is greater than the width of the bone, a state of things not approached by any of the species of this genus described in the preceding pages. The premaxillary in the *M. proprius* is not described.

From the ? Ticholeptus beds of the Sweetwater river, Wyoming.

Merycochœrus proprius Leidy.

Proceedings Academy Philadelphia, 1858, p. 24; Extinct Mammalia Dakota and Nebraska 1869, p. 110; Pl. X.

This large species represents the extreme form of the genus in the anterior position of its dental series as compared with the braincase. The zygomatic arch and infraorbital foramen are therefore more posteriorly placed than in any other species. The premaxillary bone is more prominent than in any other, and the incisor teeth have relatively larger dimensions. The size is about that of the *M. superbus*. I have not seen any other than the typical specimen.

From the Ticholeptus beds at the head waters of the Niobrara river, Nebraska.

MERYCHYUS Leidy.

Proceedings Academy Philad'a, 1858, p. 24, (nomen nudum). Extinct Mammalia Dakota and Nebraska, 1869, 115. Report U. S. Geological Survey Terrs. i, 1873, p. 202. Cope, American Naturalist, 1884, p. 281. *Ticholeptus* Cope, Bulletin U. S. Geolog. Survey Terrs., 1878, p. 380.

Premaxillary bones coössified; otic bulla swollen; a vacuity between

the maxillary, lachrymal, and nasal bones, or larmier. Nasal bones normal. First inferior premolar caniniform.

This genus has not been defined prior to the present article, although some characters common to the species of the genus known to him, have been given by Leidy. As now defined it is identical with genus *Ticholeptus* Cope. This group was distinguished by the presence of a larmier, character whose presence in the species of Merychyus has been hitherto unknown. It is not yet reported indeed as present in any of the original species of the latter, but I think that there can be no reasonable doubt of its presence there. A character found by Leidy in the *M. major* I find to be present in one or more of the superior molar teeth in all the species. The posterior horn of the anterior internal crescent cuts off the adjacent or anterior horn of the posterior internal crescent from contact with the inner side of the external wall of the crown. It is the anterior horn of the posterior internal crescent which reaches the external wall, in the genera Merycochœrus, Eucrotaphus and Oreodon. In Leptauchenia the arrangement is generally as in Merychyus; see under the head of that genus.

This genus is confined to the Upper Miocene beds, the Ticholeptus and Loup Fork epochs. In size the species range from medium to large, the *M major* equaling any species of the family in dimensions. They are distinguished as follows:

I. True molar teeth not prismatic.

Infraorbital foramen above fourth premolar; malar bone shallow, squamosal with superior zygomatic angle anterior; true molars M. .042. ... .*M. pariogonus*.

II. True molar teeth more or less prismatic.

a. Infraorbital foramen above third premolar.

Larmier a slit, front narrow.................*M. arenarum leptorhynchus*

aa. Infraorbital foramen above fourth premolar.

β. Zygomatic arch vertical, and with posterior angle small and rounded

Larmier triangular; front wide; true molar series M. .044; face convex. ....*M arenarum arenarum*.

ββ. Zygomatic arch expanded horizontally; posterior angle strong, acute.

Larmier large; true molars .051..................... .*M zygomaticus*.

βββ. Zygomatic arch unknown.

Facial plate generally concave; true molars M. .045..........*M. elegans*

True (inferior) molars, M. .069. . ...*M medius*

True (superior) molars (m. iii inferred), M. .095...............*M. major*.

Of the above species, the *M. arenarum* and *M. zygomaticus* are known from entire skulls. In the first named, the foramen infraorbitale appears to be partly above the posterior edge of the third premolar, as well as above the anterior edge of the fourth.

Merychyus arenarum Cope, sp. nov. Sub-species **leptorhynchus** Cope.

This species is represented by a skull which lacks of completeness only the extremity of the muzzle and the angles of the lower jaw. Its size is about that of the *Oreodon culbertsoni* or of the *Merychyus elegans*. The confluence of the premaxillary bones shows that the place of the species is with the last-named genus, and the sigmoid flexure of the masticating line of the superior dentition is a point of resemblance to the species of the same. The position of the external infraorbital foramen is one degree further posterior than in the species of Oreodon, and agrees with the position in two other species of Merychyus (*M. arenarum* and *M. pariogonus*), which is more anterior than in the other species of the genus. The foramen is in fact quite identical in position with that seen in most of the species of Eucrotaphus, to which genus the above named species must be regarded as the nearest in the genus to which they belong.

As in other species of the genus, the malar bone is deeper and less prominent laterally than in those of Oreodon. The preorbital fossa is wider and shallower. The orbit is closed behind.

The premaxillaries are convex in every direction, least so transversely. The fissure which separates them is quite narrow, and is separated from the alveolar border by a rather narrow isthmus of uninterrupted bone. At the canine tooth the direction of the surface becomes longitudinal by an abrupt turn, and the side of the face above the second premolar is uninterruptedly gently concave. The lateral convexity which bounds the preorbital fossa below, appears above the third superior premolar, and becomes more prominent posteriorly as it passes into the flat surface of the malar bone. The anterior orbital border is prominent and thin, and does not develop a distinct tubercle, although its edge is roughened. The profile of the muzzle is a straight line descending gently from the interorbital region. Above the middle of the orbits the frontal bones are gently convex; on the line of their anterior border, there is a concavity of the median line. The superior face of the nasal bones is flat, and is peculiarly narrowed, especially posteriorly, where the large preorbital fossæ approach each other.

The anterior temporal ridges are well marked, and after a gradual approach unite into a sagittal crest, which has a gently convex rising profile. After the posterior bifurcation of the latter, the convex posterior temporal crests do not project beyond the occipital condyles when the inferior edge of the lower jaw rests on a horizontal plane, as in so many other species of this genus and of its allies. These crests continue without interruption above the auricular meatus to the posterior base of the postglenoid process. As compared with the *Oreodon culbertsoni*, the postorbital part of the cranium is short; it is also shorter than in any other species of Merychyus. Thus the length from the posterior border of the orbit to the convexity of the

posterior temporal crest, is as long as from the former point to the anterior base of the first premolar. In the *Oreodon culbertsoni*, the same measurement is equal to the length from the same point to the anterior base of the third incisor. This shortening posterior to the orbit is seen to involve the zygomatic fossa as well as the region posterior to it. Thus the horizontal diameter of the orbit in the *M. leptorhynchus* is exactly equal to the distance between the posterior border of the same and the anterior edge of the glenoid cavity. The posterior part of the superior edge of the squamosal zygomatic process is thin and strongly convex. The apex of the convexity is above a point just anterior to the posterior border of the glenoid cavity. The posterior edge of the process is nearly vertical, and if continued would reach the middle of the base of the postglenoid process. The latter is compressed and rather elongate, and its convex edge has considerable transverse extent. The paroccipital process is long and is flat on its posterior face. The postorbital process of the frontal is elongate wedge-shaped, with its truncate apex below joining a slight elevation of the malar bone, which is much less prominent than in *Oreodon culbertsoni*. It presents an angle outwards and forwards, as the orbital border. The anterior half of the zygomatic process of the malar bone is rounded-truncate below. The glenoid surface is plane transversely, and slightly convex, rising backwards, anteroposteriorly. The anterior border of the squamosal bone is not developed into a ridge.

The frontal bone extends forwards on either side of the nasals, forming a narrow process above the lachrymal bones. It overlaps the superior edge of the maxillary, of which a narrow splint appears between it and the nasal. The nasals are rather narrow, and each has the posterior border rounded. The latter fall above the middle of the first true molar tooth when the inferior edge of the mandible is horizontal. The lachrymal bone has greater anteroposterior than vertical diameter, extending nearly to the line of the infraorbital foramen, or much in advance of its position in *Oreodon culbertsoni*, *Eucrotaphus jacksoni*, or *Merycochœrus superbus*. The malar bone has a correspondingly large anterior extension, reaching to above the posterior part of the fourth premolar. It does not extend so far in the three species just named. The zygomatic process of the squamosal is more deeply received into the malar bone than in any of the three species mentioned, reaching to below the posterior third of the orbit.

The larmier in this species is small, and its anteroposterior diameter is more than twice as long as the vertical. More than half of its inferior border is formed by the maxillary bone. As it is exhibited in the specimen, its superior border is formed by the ascending process of the maxillary bone; whether this is overlapped by the laminar process of the frontal so as to bound the foramen, when in a perfect condition, is uncertain. The posterior edge of the larmier is the lachrymal bone. The external *foramen infraorbitale* is on one side double. The supraorbital foramina form notches at the anterior edge of the supraorbital border. The frontal

foramina are well separated from each other, as in the species of Merycochœrus. The space between them is about equal to that between each one and the superciliary border. There is a large postpariëtal foramen near the pariëto-squamosal suture. If the supraglenoid foramen be present it is not distinguishable in the specimen. The orbit is rounded subquadrate, with the inferior anterior angle a little produced.

The ascending process of the mandible is relatively elevated. The horizontal ramus narrows rapidly anteriorly, and the symphysis mandibuli is produced so as to rise at a very low angle. The alveolar portion is horizontal.

The superior incisors are small and their apices are but little expanded, the external the most so. They are directed vertically downwards. The superior canine is quite small; its crown exceeds in length that of the first premolar by but little, and is directed a little posteriorly as well as downwards. The roots of the first premolar are not as well distinguished as in many other species, and are united in their extra-alveolar part at least. The same is true of the second premolar. The apex of the cutting edge is in line with the anterior border of the crown; the rest of the edge rises obliquely backwards. In the third premolar there is a slight bevel in front of the apex, which is much better developed on the fourth. These teeth are more truncate than the corresponding ones of the species of Oreodon and Eucrotaphus, and the larger species of Merycochœrus. The external faces of P-m. i and ii are convex; that of P-m. iv is concave, but without the reverted vertical borders seen in *Oreodon culbertsoni*. The first true molar has long roots and a short crown. The last two molars have crowns of a more elongate character, with well developed anterior and middle ridges. The latter are not so prominent as those of the molars of the *Merychyus zygomaticus*.

The inferior incisors are directed upwards at an angle of about 30°. They are similar and closely packed. The inferior canine is in close contact with the third incisor, from which it differs in its larger, leaf-shaped crown. The inferior first premolar is a slender one-rooted caniniform tooth, with narrow crown and acute apex. The second premolar is one-rooted, and has a leaf-shaped crown, with acute-angled apex. The third is two-rooted, and has a wider and nearly symmetrical crown. The fourth is much larger, and its elongate crown laps inside of that of the third. Its low angular apex is median. The last inferior true molar is disproportionately larger than the others. No external cingula.

Measurements of Skull.	M.
Length from occipital condyle to premaxillary border..	.161
" " " " " postglenoid process...	.030
" " " " " postfrontal process...	.078
" " " " " preorbital border.....	.130
Diameters of orbit { vertical..........................	.0250
Diameters of orbit { transverse.......................	.0255

Measurements of Skull.	M.
Depth of malar bone at middle of orbit	.0195
" " zygomatic process at glenoid face (greatest)	.021
Width of top of muzzle at larmier	.0175
" at middle of supraorbital border	.051
" " malar bones	.077
" " zygomatic processes of squamosal	.0795
" of occipital condyles	.031
Elevation of occiput, including condyles	.054
Width of occiput at middle	.033
Depth skull at right angles to profile, at glenoid face	.046
" " " " " " orbit	.049
" " " " " " larmier, exclusive of teeth	.044
Depth of mandible at condyle	.071
" " " m. ii (middle)	.025
" " " P-m. iii	.022
Length of superior dental series	.0885
" to superior P-m. i	.0130
" " " m. i	.0470
" of " m. iii	.0180
" " " canine, crown	.009
" to inferior P-m. i	.012
" " " m. i	.0425
" of " dental series	.087
" " " m. iii	.022

The unique and beautiful specimen on which our knowledge of this species rests, was found in a formation of the Ticholeptus Miocene near Laramie Peak, Wyoming Territory, by my assistant, J. C. Isaac.

Merychyus arenarum, sp. nov. Sub-species **arenarum.**

This species was more abundant than the *M. leptorhynchus* during the Ticholeptus epoch, if we may judge from the number of specimens which have been procured. I enumerate here the five most important, viz.: No. 1, A skull which lacks the muzzle as far as the preorbital fossa, and the palate as far as the third premolar, and which has the mandible complete as far as the coronoid processes, and which is accompanied by fore and hind feet and other limb bones. No. 2, A muzzle and right side of the face including the orbit, with the entire dentition, including that of the premaxillary bone, and that of the right mandibular ramus as far as the second true molar inclusive. No. 3, A skull with a part of the mandible of an immature individual, in which the last superior molar is just appearing, and the last two temporary molars are in place, and which is accompanied by a few bones of the limbs. No. 4, Palatal part of skull with nearly all the teeth, accompanied by perfect mandible with all the teeth, and a large part of the skeleton. No. 5, A skull from which the basi-

cranial region, zygomata, and left maxillary bone, have been lost. The measurements of No. 4 somewhat exceed those of the other specimens, so that it is doubtful whether it really belongs here.

The characters which distinguish this form from the *M. leptorhynchus* are not numerous. In the first place the front and muzzle are relatively wider. Secondly, the larmier is of a different form. Instead of being a horizontal slit, it is subtriangular, with the base above, and the angle below; thirdly the canine teeth are more robust in both jaws. But the position of the infraorbital foramen is slightly variable, and the width of the front in one specimen is about as in the sub-species *leptorhynchus*. The size of the canine is not invariable. I am therefore precluded from regarding the *M. leptorhynchus* as more than a sub-species.

As compared with the *M. elegans*, the strong convexity of the side of the face distinguishes it. The convexity continues from the malar region forwards above the infraorbital foramen, and nearly reaches the nareal opening. Judging from Leidy's fig. 11, Plate XI, of the Extinct Mammalian fauna of Dakota and Nebraska, the premaxillary bone of the *M. elegans* is flatter than in the *M. arenarum*. The infraorbital foramen has a more anterior position in the latter than in the former.

The size is always a little larger than in the type specimen of *M. leptorhynchus*.

Measurements.

No. 1.

	M.
Length from occipital condyle to postglenoid process	.037
" " " " " postfrontal process	.076
" " " " " preorbital border	.105
Transverse diameter of orbit	.030
Depth of malar bone at middle of orbit	.019
" " zygomatic process at glenoid face (greatest)	.019
Width at middle of supraorbital border	.062
" " malar bones	.096
" " zygomatic process of squamosal	.100
" of occipital condyles	.034
" " occiput at middle	.036
Elevation of occiput including condyles	.054
Depth of skull at right angles to profile at glenoid face	.041
" " " orbit (exclus. teeth)	.051
" of mandibular ramus at m. ii	.030
" " " " P-m. iii	.022
Length of last five superior molars	.064
" " true molars	.048
Diameters P-m. iii { anteroposterior	.010
Diameters P-m. iii { transverse	.010
Diameters m. i { anteroposterior	.013
Diameters m. i { transverse	.013

Measurements. M.

No. 1.

Diameters m. iii { anteroposterior	.019
Diameters m. iii { transverse	.015
Length of inferior dental series (axial)	.098
" " premolar series (axial)	.038
Long diameter of crown of canine	.007
" " " P-m. i.	.0086
" " " P-m. ii	.0084
Diameters P-m. iv { anteroposterior	.012
Diameters P-m. iv { transverse	.009
Diameters m. ii { anteroposterior	.0147
Diameters m. ii { transverse	.010
Diameters m. iii { anteroposterior	.0223
Diameters m. iii { transverse	.010

The specimens all came from the Ticholeptus beds near Laramie Peak, Wyoming, and were discovered by my assistant, J. C. Isaac.

Merychyus pariogonus, sp. nov.

The generic position of this species is uncertain, and it may belong to Merycochœrus or even to Eucrotaphus, as its otic bullæ are inflated. The doubt as to its position is due to the fact that the anterior part of the skull of the typical specimen is lost as far back as the anterior border of the orbit, and the second molar tooth. I place it here provisionally because the internal crescents of the superior molars are arranged as in *M. major* and *M. arenarum*, *i. e.*, with the anterior crescent excluding the posterior at the point of junction of the two.

The *Merychyus pariogonus* is about the size of the *Oreodon culbertsoni*. The braincase is full, so that the internal side of the temporal fossa is strongly convex, but without very prominent ridge along the parieto-squamosal suture. The anterior temporal ridges unite at an acute angle, but the sagittal crest is obsolete as far as a point above the posttympanic process, where it gradually rises. The posterior temporal ridge is prominent superiorly, but is not produced beyond the line of the occipital condyles. It is discontinued in the direction of the supraauricular ridge, but continues downwards as an obtuse ridge on each side towards the foramen magnum. Between this and the squamoso-occipital angle is a large open fossa which is present in the species of this genus, of Merycochœrus and of Eucrotaphus, but is wanting in *Oreodon culbertsoni*. In the obsolescence of the posterior temporal crest it agrees with the last named species, and with some of those of Merycochœrus, but differs from *Eucrotaphus jacksoni* where it is low, and from *Merychyus leptorhynchus* where it is well developed. In the size of the lateral occipital fossæ the species exceeds any of the others of this family. Below the depression the posterior temporal crest rises abruptly, forming a convex edge which continues downwards nearly obsolete, on the suture between the pos-

tympanic and paroccipital processes. It is not distinctly continuous over the auricular meatus. The paroccipital process is elongate and acuminate, and becomes compressed so as to be anteroposterior for the greater part of its length. The auricular meatus occupies but a small part of the space between the posttympanic and postglenoid processes. It is partially enclosed by the robust rounded ledge of the squamosal bone, which separates it from the postglenoid process. This ledge is much more developed than in any other species of this family known to me The bulla of the petrous bone is longer anteroposteriorly than transversely, and its anterior and posterior borders coincide with the anterior border of the postglenoid process, and that of the paroccipital process. The postglenoid process is robust, much as in the large species of Merycochœrus, and not compressed as in *Merychyus leptorhynchus* and *M. arenarum*. The zygomatic arch is slender. The elevation of the posterior part of the zygomatic process of the squamosal has a different form from that seen in the species last named It is angulate, not rounded. The position of the angle is different from that in *M. zygomaticus* in being more anterior, marking a point well in front of the anterior base of the postglenoid process The border which connects the angle with the supra-auricular crest is then not vertical as in the species just mentioned, but is oblique, and it is also somewhat concave. The malar bone is shallow and stout, with truncate edge below The squamosal process enters it to below the posterior third of the orbit. The postfrontal process is slender, and the postorbital process of the malar is elongate, meeting the former opposite the middle of the orbit. It is thus longer than in any species of the family known to me

The frontal foramina are separated by an interspace equal to four-fifths the distance between each and the superciliary border. The pariëto-squamosal suture ascends posteriorly in a nearly straight line to within M. .015 of the posterior zygomatic crest The posterior squamosal suture then turns directly downwards, reaching the depressed portion of the crest where it bounds the huge mastoid fossa and foramen.

The posterior part of the mandibular ramus, shows a regularly convex angular border commencing just below the condyle. The coronoid process is quite small and the short connecting edge between it and the condyle is not excavated below the level of the latter The articular face of the condyle is directed upwards, and on the internal third, presents a face posteriorly also. The ramus diminishes rapidly in depth anteriorly. The masseteric fossa does not descend below the level of the second true molar, and is not sharply bordered anywhere. The internal pterygoid fossa on the other hand occupies the entire inner face of the angle between the condyle and the inferior border, and anteriorly to the line of the last inferior molar tooth

The superior true molars have short crowns, as in Eucrotaphus and Oreodon. The anterior and median vertical ridges are very prominent, and the posterior vertical border of the posterior column projects to a slight

extent posteriorly. Enamel smooth. The last inferior molar is not disproportionately larger than the second as in *M. leptorhynchus*, *arena* and *elegans;* and with the second, has little of a prismatic character. cingula.

Measurements.	M.
Length from occipital condyle to postglenoid process...	.047
" " " " " postfrontal process. .	101
Vertical diameter of orbit	036
Depth of malar bone at middle of orbit.	.012
" " zygomatic process at posterior angle	024
Width at middle of supraorbital border..	060
" " malar bones	.090
" of occipital condyles	032
" " occiput at lateral crests	030
" " " " condyles	061
Elevation of occiput with condyles.	.054
Depth of skull at glenoid surface	059
" " " " orbit, exclus. malar.	054
" " mandible at condyle	075
" " " " coronoid.	083
" " " " posterior edge of m. iii	042
Depth mandible at middle of m ii...	028
Diameters superior m. ii { anteroposterior	016
{ transverse..........	.016
Diameters superior m. iii { anteroposterior.	.020
{ transverse	0155
Diameters inferior m. ii { anteroposterior	015
{ transverse.	.012
Diameters inferior m. iii { anteroposterior.	0225
{ transverse..........	0115

A second specimen of this species consists of the occipital, parietal, a part of the frontal regions, with the right maxillary bone, and fragments of the left maxillary, of the mandible, etc The latter demonstrates the position of the infraorbital foramen to be above the anterior border of the fourth superior premolar. The middle line of the occiput presents a keel on its superior half The basioccipital bone between the paroccipital process is expanded laterally, and is without median angle or groove. Between the bullæ it is compressed, and its middle line forms a narrow truncation. Opposite the posterior third of the bulla, this surface ascends at an angle and gradually widening, spreads into the general flattened convex inferior face of the sphenoid The anterior part of the sagittal crest is a little better developed than in the typical specimen. The worn teeth indicate an old individual The canine is large, and the first premolar has its roots well distinguished The facial plate of the maxillary concave above second premolar No appreciable diastema.

Measurements.		M.
Length of molar series		.081
" " premolars on bases		.041
Width of canine posteriorly		.010
Diameters P-m. iv	anteroposterior	.010
	transverse	.012

Of this species I have but two specimens, which were obtained from the Ticholeptus beds of Deep river, Montana, by my assistant, J. C. Isaac.

Merychyus elegans Leidy.

Proceedings Academy Philada., 1858, p. 24. Extinct Mammalia Dakota and Nebraska, 1869, p. 118, Pl. XI, figs. 1–11.

Niobrara river, Nebraska.

Merychyus zygomaticus Cope.

Ticholeptus zygomaticus Cope, American Naturalist, Feb. 1878. Bulletin U. S. Geolog. Survey Territories, 1878, p. 380.

This species is peculiar in having the posterior expansion of its zygomatic arch horizontal instead of vertical. It has a thickened external edge which continues into a strong posterior angle which projects behind the posterior margin of the postglenoid process. The auricular meatus is directed posteriorly in a way quite peculiar, resembling somewhat the position seen in some of the hogs. The malar bone is very prominent. The infraorbital foramen is above the contact of the third and fourth superior premolars. The larmier is large and its maxillary border descends posteriorly.

In size this species is between the *M. elegans* and the *M. medius*. If my identification of New Mexican specimens is correct, this species differs from the *M. medius* in the much less production of the premaxillary region, besides the smaller size.

Ticholeptus beds of Deep river, Montana ; J. C. Isaac.

Merychyus medius Leidy.

Proceedings Academy Philad'a, 1858, p. 25. Extinct Mammalia, Dakota and Nebraska, 1869, p. 119, Pl. XI, figs. 12–14. Cope U. S. Expl. Surv. W. of 100th Mer., G. M. Wheeler, iv, pt. ii, p. 324.

Niobrara river, Nebraska, Hayden ; Santa Fé, New Mexico, Cope.

Merychyus major Leidy.

Proceedings Academy Philada., 1858, p. 26. Extinct Mammalia, Dakota and Nebraska, 1869, p. 121, Pl. X, figs. 15–16.

This species, known hitherto from Leidy's descriptions of four of the superior molars, is the largest of the genus, and perhaps of the family. More information regarding it is much to be desired.

Headwaters of the Niobrara river ; from Loup Fork beds, according to Hayden.

LEPTAUCHENIA Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, 122. Proceedings Academy Philad'a, 1856, 88, (nomen nudum). loc. cit. 1856, 163 (nomen nudum).

As already remarked by Leidy, this genus is characterized by the presence of enormous vacuities of the superior surface of the muzzle. The genus might be described as lacking the usual superior osseous wall of the nasal cavities and maxillary sinuses. The generic diagnosis is as follows:

Otic bullæ inflated. Four premaxillary teeth. Nasal bones excessively contracted, leaving a wide interspace between them and the maxillaries. Symphysis mandibuli coössified.

This genus has but a short range in time, not having been yet found out of the Ticholeptus beds. It shows in its deficient ossification, and smaller size, that this line of the family was approaching its extinction, its decadence having already commenced in the genus Merychyus. The genera which follow in systematic order, Cyclopidius and Pithecestes, exhibit the last steps in the downward course.

I. Infraorbital foramen above P-m. iii.

"Three inferior incisors; nasal sinuses to middle of orbit; true molars .043, skull .135." (Leidy) . . . . *L. major.*

"Nasal sinuses not extending so far posteriorly as in *L. major;* true molars .032; skull, .101." (Leidy) . . . . *L. decora.*

"Nasal sinuses reaching to front of orbit; true molars .020; skull .085." (Leidy) . . . . *L. nitida.*

Leptauchenia major Leidy.

Proceedings Academy Philad'a, 1856, p. 163; 1857, 89. Extinct Mammalia, Dakota and Nebraska, 1869, p. 124, Pl. XII, figs. 1–5.

Tributaries of White river, Nebraska.

Leptauchenia decora Leidy.

Proceedings Academy Philadelphia, 1858, p. 88; 1857, p. 89. Extinct Mammalia of Dakota and Nebraska, 1869, p. 127, Pl. XII, figs. 6–20.

Tributaries of White river, Nebraska.

Leptauchenia nitida Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, p. 129; Pl. XII, figs. 21–23.

White Earth creek, Dakota, tributary of the White river.

CYCLOPIDIUS Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx* Cope, Ibidem, p. 220.

Dental formula I $\frac{2}{?}$ C. $\frac{1}{?}$. P m. $\frac{4}{?}$; M. $\frac{3}{?}$. Premaxillary bones much reduced; mandibular rami coössified. Otic bulla inflated. Prelachrymal vacuities present, and confluent with enormous nasal vacuities, which are due to the excessive reduction of the nasal bones. Orbit closed behind.

This genus is Leptauchenia without superior incisor teeth, and with but two on each side below. I originally asserted the presence of superior incisor teeth, and it is true that there is in early life a minute tooth in each premaxillary bone, as indicated by the alveoli in a specimen which contains the full deciduous molar dentition. I have not seen the teeth themselves, and it is evident that they are early shed. In an adult specimen of *C. simus* it seems that the alveolar portion of the premaxillary bone has been absorbed.

The meatus auditorius externus occupies a more elevated position in this genus than in any other of the family. It is also directed somewhat posteriorly. There are postpariëtal foramina.

The cerebral hemispheres are not large, and scarcely rise above the plane of the summit of the large cerebellum. Convolutions three on each side, weakly defined.

The concavity of the superior border of the premaxillary bones, together with their upward production, leads me to suspect that the external nares were superior in position. This is the indication of an aquatic habit of life, such as is led by the hippopotamus. Like that animal, the nostrils in Cyclopidius were probably valvular to prevent the ingress of the water. The animals probably passed much of their time in the water, and the nostrils could be brought to the surface for the purpose of respiration, while the remainder of the head and body remained concealed. The prominent rim of the auditory meatus suggests a similar valvular closure of the organ of hearing, and is also a provision for its easy approximation to the surface of the water when necessary.

The milk dentition is like that of Artiodactyla in general. That is, in the superior series the third molar is more elongate and complex than its permanent successor, and the fourth is like the first permanent true molar in constitution. In the inferior series the anterior three teeth resemble the permanent premolars, while the fourth is trilobate.

In the loss of the incisor teeth and the subprismatic molars, we observe in Cyclopidius the same evidences of specialization already known in other types of Ungulates.

I know of but two species of Cyclopidius.

Cyclopidius simus Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx feliceps* Cope, Ibidem, p. 220 (immature).

The specimens of this species in my possession embrace a complete skull with one zygoma and half of the brain case wanting, a left maxillary bone with all the teeth, and three mandibular rami with dentition, all of adults. Of immature individuals, I have two muzzles with dentition of both sides, and six mandibular rami; in all, parts of thirteen individuals. The following description of the skull is taken from the specimen first named, which is the type of the species.

The cranium is wide and depressed, and the muzzle is short. The pro-

file descends at the orbits into the nasal vacuities, which cause a deep excavation of the facial plate of the maxillary region. The small nasal bones form a promontory below the level of the orbits, whose superior borders are convex. The maxillary bones rise at the end of the muzzle, forming, probably, with the confluent premaxillaries, a subquadrate projection. The superior side of this process is concave on its interior aspect forming a curved suture of an expanded nasal bone. Its anterior edge is also concave on their inner side, as though adapted to a forward-looking nareal opening. This anterior border is produced downwards into a free conical process which bounds the canine alveolus in front. This I suppose is all that there is of the alveolar portion of the premaxillary bone. The corresponding part of the other side is lost. There is a well-marked preorbital fossa. Its supero-interior border bounds the huge nasal vacuity on each side. The nasal bones form a narrow promontory, with convex superior face, which extends a little beyond a line connecting the middles of the preorbital fossæ. The vacuities excavate the frontal bones as far back as a line connecting the middles of the supraorbital borders. The frontal bone is thus of a Λ-shape. The anterior temporal ridges are well defined, but do not reach the free edge of the frontal bone. Their union into the sagittal crest is gradual. The brain-case is moderately elongate, the postorbital process of the malar bone marking the middle of the total length. In profile the posterior part of the skull is nearly straight. The sagittal crest is gently convex, and is not so deeply bifurcated posteriorly as in most other forms. The posterior temporal crests are expanded laterally, and continue well developed to above the meatus auditorius, into the superior edge of the zygoma. They are not continued downwards on the occiput, as in most of the other genera of the family, but resemble the species of Merychyus more than any others in this respect. The temporal fossa has a wide floor, due to the lateral extension of the meatus auditorius, and the glenoid portion of the squamosal. The superior edge of the zygomatic process of the squamosal is little elevated, and is regularly convex. The process is not produced as far anteriorly as the posterior border of the orbit. The malar bone is remarkable for its depth, exceeding in this respect any species of the family yet known. Its external face slopes obliquely outwards below, but not very much, and is slightly and uniformly convex. Its inferior edge is thickened and descends anteriorly, and then thins and rises continuously to the zygomatic process of the squamosal.

The occipital aspect of the skull is wide and low. Its superior region is slightly convex and roughened on each side of the median line. From and below this valley, the middle line presents a sharp carina, which disappears in a narrow convexity above the foramen magnum. Between this convexity and the meatus auditorius, the surface is concave. The occipital condyle is small, and the exterior half is more extensive than the posterior half. The paroccipital process is large. Its base diverges from the occipital condyle, and is adherent by its anterior face to the otic bulla,

without intervening ridge. The posttympanic mass is broken away. It is inferior in position to the auricular meatus. The latter, being directed posteriorly, is considerably produced behind the postglenoid process, leaving a wide postglenoid fossa. The postglenoid process is rather small, and its posterior face is entirely covered by the tympanic bone, while its interior edge is in close contact with the otic bulla. The bulla is of enormous size, and is a slightly compressed oval placed anteroposteriorly. It fills the entire space between the postglenoid process and the basicranial axis, and reaches anteriorly almost to the line of the anterior border of the glenoid region. The pterygoid process adheres to its internal wall for half its length, and it sends forwards on the external side of the pterygoid, a narrow acuminate apex. The internal extremity of the glenoid cavity is concave, and the surface descends, forming a robust peduncle, as large as the postglenoid process, to which the anterior part of the otic bulla is attached. This is a character I have not seen in any other species of the family. A wide surface, continuous with that of the glenoid face, extends on the external side of the pterygoid ala of the sphenoid, to the angle where it unites with the pyramidal process of the palatine. It there terminates abruptly, but the external angle marks the end of a ridge, which extends upwards and forwards to the postorbital process of the frontal. Anterior to this line the cranial wall is concave; posterior to it, convex. The processi pyramidales are divergent, and have thickened and rounded inferior edges. The maxillary bones are produced a little beyond their bases, leaving a notch between. The palatal surface is uniformly moderately concave.

The incisive foramina are large; the septa are wanting in my specimens, perhaps accidentally. The infraorbital foramen is above the middle of the fourth premolar tooth. The frontal foramina are further apart than in any other species of the family, being equidistant between the median line and the supraorbital border. There is an internal orbital foramen below the postorbital process, as in other species of the family. There are three postpariëtal foramina, two of which are on the squamosal suture. Below the anterior of these two is a large postsquamosal foramen. No supra or postglenoid foramina. The meatus auditorius externus looks equally externally and posteriorly. It is large and of oval outline, the long diameter being parallel to the superior border, which is the usual suprameatal crest. Its tympanic or anterior border is very prominent, while the posterior border is a little less so. A posttympanic tuberosity marks the middle of the inferior edge. Posterior to the meatus is the rather large mastoid foramen, which is above the internal base of the paroccipital process. The basicranial bones being lost, the characters of the basal foramina are not determinable. The posterior nares are deeper than wide. The palatonareal border is a Gothic arch, of which the apex is opposite the posterior border of the last molar tooth. I perceive no palatal foramina.

The median and posterior nasal sutures remain. The latter is a V with

the apex opposite to the frontal foramina. Lambdoidal suture confluent. The malosquamosal suture marks the posterior edge of the posterior orbital rim at the middle of the orbit. The pariëto-squamosal suture has an inferior position in front. Opposite the front of the postglenoid process it converges inwards in line for the occipital bifurcation, and is continued as the pariëtoöccipital suture, nearly to that point. The squamosal border, however, extends in a Z-form to the posterior temporal crest half-way between the bifurcation and the meatus auditorius. It embraces an area of the posterior face of the skull, and the posterior half of the rim of the auricular meatus.

The typical specimen presents only the alveoli of the canine and first premolar teeth; otherwise the dentition is perfect. The crowns of the second and third premolars are obliquely quadrate in horizontal section, both a little wider posteriorly than anteriorly. This is due to the presence of a half crescent of the internal side, whose posterior horn is attached to the external wall, while the anterior is free. The external faces of these premolars is slightly convex; of the fourth premolar is slightly concave. The first true molar is decidedly smaller than the second, and the second is smaller than the third. The external sides of the external columns are flat in the first true molar, but become more concave on the third. The anterior edges of the columns project; forming ridges; or in section, projecting angles. No intermediate ridges, nor cingula. The third superior true molar has a prismatic crown, no roots being visible in either of the adult specimens, of which the typical one is rather old, as indicated by the wear of the teeth. In the latter specimen the roots of the second true molar are apparent, although the crown is elevated. The first true molar is not prismatic, although the crown is not low. The specimen represented by the left maxillary bone contains the teeth which are wanting from the typical one. The section of the crown of the canine is a semicircle, the truncate face being posterior internal. It is not a large tooth, and is separated from the first premolar by a diastema equal to its diameter. The first premolar is one-rooted, the root with a groove on the internal side. The section of the base of the crown is a triangle, the faces being anterior, external, and posteroïnternal. Its inner face is concave above the base.

None of the separate mandibular rami are complete, all lacking the angle and condyle. The former is full and round, judging from a fragment in my possession. The ramus diminishes regularly in depth forwards. The symphyseal region is short, and its anterior face is very steep except at the alveolar region, where it is everted forwards. No trace of suture. The internal pterygoid fossa is large and strongly marked, so that the inferior edge of the ramus is inverted, so that the surface is convex externally. The last molar is placed somewhat obliquely. The first and second premolars are directed outwards and forwards, and the incisors directed forwards.

There are two incisors on each side of the symphyseal line. They are very small and subcylindrical, and are closely packed between the canines.

The canines are much larger, with cylindric root and flat, incisor-like crown. The first premolar is still larger, and is of about the same form as the canine, from which it is only separated by a slight divergence of the crowns. There are no diastemata. The second premolar has a compressed triangular crown, with a median ridge on the internal side. Its long diameter is diagonal, running outwards posteriorly. The long axis of the third premolar is similar, while the other teeth are more nearly in line. In the third premolar the fossa interior to the median internal heel is much deeper than that posterior to it. The corresponding fossa is still larger in the fourth premolar, while the crown has a heel in the form of a transverse curved crest, separated from the median heel on the inner side by a fissure. The true molars increase rapidly in size posteriorly, but not so abruptly as in the *Pithecistes brevifacies*. The internal crescents are very flat, and the posterior edges of their columns project moderately. The external crescents are very convex. The prismatic character of the teeth increases much posteriorly, so that the roots of the third tooth are short, and the crown long. The enamel is minutely rugose.

The third superior temporary molar has two pairs of crescents. The anterior pair are, however, not so well developed as the posterior pair and the two valleys are soon obliterated by wear. The crescents are equal in the fourth temporary molar. The fourth permanent premolar is protruded at least as soon as the third true molar, sooner than the posterior column of the latter. In this it differs from the *Oreodon culbertsoni*, where the last true molar is protruded first, and is a cotemporary of both the third and fourth deciduous molars ;* and the *O. gracilis*, where the last true molar is a cotemporary of the third deciduous.

In the inferior temporary dentition, the lobes of the last molar are subequal, the posterior one being a little the larger. The protrusion of the last true molar is also probably delayed until the shedding of the deciduous series, as in the superior series ; but my specimens are either very young or fully adult, and therefore I cannot demonstrate this point as fully as in the case of the superior series.

Measurements of Skull.

	M.
Length from condyle to front of canine inclusive	.117
" " " " otic bulla (axial)	.010
" " " " palatonareal notch,	.0575
" " " " anterior line of glenoid cavity.	.038
Depth of occiput, including condyle	.041
" at middle of orbit, exclusive of teeth	.037
" " infraorbital foramen " "	.016
" " premaxillary border " "	.023
Width at " " above	.022
" between orbits	.038

* Leidy. Ancient Fauna of Nebraska, 1853, p. 51, Pl. IV, figs. 1, 2.

Measurements of Skull.

		M.
Width at malars below orbits		.086
" " zygomata at middle		.092
" " auricular meatus		.070
" of occipital condyles		.0275
" at middle of last molars inclusive		.049
" " " second premolars inclusive		.080
Diameters otic bulla	anteroposterior	.028
	transverse	.018
	vertical	.019
Diameters of nasal bones	length of fragment of	.024
	width at base	.0125
Length of dental series		.062
" " premolar series		.025
" " true molar		.038
Diameters P-m. iii	anteroposterior	.007
	transverse	.0065
Diameters m. i	anteroposterior	.0085
	transverse	.0085
Diameters m. iii.	antereposterior	.0146
	transverse (greatest)	.011
Depth of mandibular ramus at m. iii		.031
" " " " P-m. iv		.019
Length of symphysis		.0245
" " premolar series		.022
" " true molar		.035
" " of total dental series		.063
Diameters P-m. iv	anteroposterior	.0085
	transverse	.006
Diameters m. i	anteroposterior	.009
	transverse	.0068
Diameters m. iii	anteroposterior	.016
	transverse	.0062

The second specimen with permanent dentition is of smaller size than the type, and the canine teeth are small. It may have been a female. The dental series, including the canine, measures M. 0.59; the premolar series 0.23; the true molars, 0.31.

The number of specimens of this animal found in the restricted area of the Ticholeptus bed of Deep river, Montana, shows the former abundance of the species. It was probably gregarious, in the manner of the other Oreodontidæ. We can depict it as seeking the swamps of the shore for its vegetable food, and spending much of its time in the water when not feeding. It was doubtless a good swimmer, and the characters of its feet will be sought for with interest for light on this point. The use of the huge superior nasal vacuity of the skull of this genus and Leptauchenia ca-

only be guessed. Perhaps it supported an inflatable bladder like that of the crested seal, or a swollen muzzle like that of the saiga antelope.

Cyclopidius emydinus, sp. nov.

This species is represented in my collection by a nearly perfect cranium. It indicates an animal of about the same size as the *C. simus*. The differences between the two species may be enumerated in advance of the detailed description. Firstly, the external vertical ridges or crests of the true molars are directed obliquely forwards so as to overlap the external wall of the anterior crescent much more extensively than in *C. simus*. (2) The crowns of the true molars have a relatively greater transverse diameter. (3) There is a peculiar process at the external base of the otic bulla, between the paroccipital and postglenoid processes, which may be called the subtympanic process. (4) There is no median occipital keel. (5) The maxillary bone is prolonged posterior to the last superior molar, which it is not in *C. simus*. (6) The oblique orbitosphenoid ridge is wanting. (7) The otic bullæ are shorter and wider in their form. This character will require confirmation by examination of many individuals.

The skull is singularly depressed and expanded laterally, so as to present an outline not unlike that of some river turtles. The orbits are in the anterior half, and look forwards and upwards, as well as outwards. The muzzle is short, so that its lateral borders approximate rapidly to a narrow truncate extremity. The maxillary borders do not contract quite so abruptly, and are visible outside of the canthus rostralis, when the skull is viewed from above. The brain-case is depressed, and is expanded posteriorly, and narrowed at the anterior line of the zygomatic foramina. The posterior temporal ridges are much expanded, forming a wide rim round the brain-case posteriorly, which is continued into the squamosal processes of the zygoma on each side. The anterior temporal ridges approach each other very gradually on the middle line, and only reach the union into a sagittal crest a centimeter posterior to the frontopariëtal suture. The edge of the crest is truncate, and it is not bifurcate posteriorly, as in most Oreodontidæ.

The occiput is broad and low, and differs in character from that of most other members of the family. Its posterior face is flat, only interrupted by a fossa on each side, just within the posterior edge of the meatus auditorius externus. This edge is continued downwards into the external border of a distinct mastoid process, which is also the external border of the occiput, deflected a little forwards. The paroccipital process is flat at the base, and is applied to the external half of the otic bulla. Its free extremity is subround. The mastoid process forms a prominent ala of its external side, having a transverse width equal to that of the base of the paroccipital. Its inferior edge is truncate obliquely outwards and downwards to a subacute angle. The occipital condyles are relatively small.

The external meatus of the ear looks outwards and backwards at an angle of 45° to the middle line. The prominent edge of the mastoid pro-

cess is directly below its anterior border. Thus the tympanic bone is directed obliquely downwards and forwards. Posteriorly it is separated by a groove from the mastoid process. Anteriorly it is separated by a fossa from an osseous mass which occupies the space between it and the postglenoid process. Before the skull was reconstructed from its fragments, this mass was observed to be entirely distinct from the postglenoid process, which it equals in height. Continuous with it, there descends another osseous body to near the line of the extremity of the mastoid process, with a truncate inferior edge, which is separated from the otic bulla by an open groove. The stylohyal ligament is probably inserted into a fossa at the anterior extremity of this groove. The postglenoid process is low and more extended transversely. The anteroposterior diameter is small. The glenoid surface is much extended transversely and terminates externally in a slight thickening. The zygomatic process of the squamosal bone is at first expanded horizontally and has a low convexity of the thin superior edge. Its vertically compressed portion is entirely supported by the malar, and does not extend so far forwards as the anterior edge of the zygomatic foramen. The malar bone is remarkable for the depth of its suborbital portion, which fully equals the diameter of the orbit. Its inferior edge presents a thickened angle downwards below the anterior part of the last superior molar. Its superoanterior angle terminates in a prominent rib of the side of the face, which extends along the inferior edge of the facial vacuity. Beneath the anterior part of the latter the face is concave. Above this concavity the ascending plate of the maxillary is convex in the vertical section, turning inwards at the apex to unite with the lateral part of the extremity of the nasal bone. The preorbital fossa is small and looks forwards and upwards.

The otic bullæ are larger than in any other Oreodontid. They are of a short oval form, somewhat truncate anteriorly and posteriorly. Thus they differ from those of *C. simus*, where they are elongate-oval. They only reach as far anteriorly as the middle of the internal extremity of the glenoid surface; while in *C. simus* they reach the line of the posterior outline of the zygomatic foramen. They terminate near the inferior internal point, in a little acute osseous apex, which is smaller than in *C. simus*. The bullæ approach so closely together that the bassioccipital is much narrowed, and the sides of its inferior surface are excavated so as to reduce the middle line to a narrow acute keel. The lateral excavations follow the posterior internal base of the bullæ, leaving a median table, which is itself excavated by a shallow fossa, which extends from the median keel to the foramen magnum. The median keel disappears anteriorly. The sphenoid is protuberant downwards as a narrow convex rib, which rises and disappears in the presphenoid. The descending sphenoid ala forms the posterior boundary of the posterior nareal trough, and makes a strong angle with the pyramidal process of the palatine, which is turned outwards. The pterygoid squama terminates in an apex which points downwards and posteriorly towards the apex of the otic bulla. The palatonareal border

V-shaped, and is in line with the posterior edge of the maxillary bone. The latter projects beyond the last molar tooth as far as the anteroposterior diameter of the latter. It has no projection in the *C. simus*. There is no notch between the maxillary bone and the processes pyramidalis of the palatine. The palate is of nearly equal width from the last molar to the third premolar; its roof is gently concave posteriorly; nearly flat anteriorly.

The premaxillary bone is a narrow strip which rises nearly vertically from its short alveolar border, and is curved outwards above in agreement with the expansion of the anterior edge of the maxillary, to which it is united by simple suture. The nasal bones are of remarkable form. Together they enter the anterior part of the frontals in a V-shape, and extend forwards in a narrow shaft. Opposite the anterior borders of the orbits the shaft begins to widen gradually, and the surface to flatten, until they reach the posterior angle of the ascending part of the maxillary. Each one then expands outwards, terminating in a semi-disc which fits the concavity of the superior edge of the maxillary above mentioned. The entire shape of the nasal bones is that of a spade with a triangular apex to the handle, and the short blade at the opposite (anterior) extremity. The frontal bone is V-shaped, the angle posteriorly directed, and engaged between the pariëtal bones, and each branch terminating above each orbit. Narrow prolongations extend anterior and posterior to the orbit, joining the lachrymal and malar bones respectively. Its median suture is, like that of the nasal bones, well defined. The alisphenoid and pariëtal have extensive connection. The pariëtosquamosal suture is horizontal in front; it then gradually rises. It is not associated with a ridge as in some other species. The occipital forms the posterior five millimeters of the sagittal crest.

The nasal opening is subtriangular, with the base above, and is directed anteriorly. The facial vacuities are enormous, and excavate the frontals to a point which make the anterior third of the orbit's diameter. They are only separated on the median line by the very narrow isthmus of the nasal bones. The infraorbital foramen is above the anterior part of the fourth surperior true molar. The frontal foramina are small, and are not symmetrical. That of the left side is half-way between the median suture and the superciliary border; the other is nearer the superciliary border. No supraglenoid foramen. Postsquamosal present; that part of the cranial walls is injured. The anteroposterior diameter of the orbit exceeds the vertical. The auricular meatus is the largest known in the family, and it has a prominent border and regularly oval outline. Its long diameter rises posteriorly from the horizontal. It is more laterally and less posteriorly directed than on the typical and only skull of *C. simus*. The foramen magnum has an openly angulate superior border. Jugular, condyloid, and carotid foramina not obvious, owing to the close contact of the otic bulla with surrounding bones. *Foramen ovale* larger than the *F. lacerum anterius*, and external to it in position. *F. rotundum* still larger, inferior in position, bounded on the external side by a

tuberous projection of the angle from the anterior edge of the glenoid surface. There is a deep fossa at the internal base of the postglenoid process, which possibly enters a foramen. No postglenoid foramen

Although the skull of the *Cyclopidius emydinus* is more robust than that of *C simus*; the length of the tooth line is the same. The incisive edge of the premaxillary bone displays one empty alveolus from which the single incisor was easily shed. The canine is not large, and the base of the crown has a regularly convex anteroexternal face, apex lost. The diastema posterior to it is equal to its diameter. The crowns of the premolars are worn, they are of about the size and proportions of the *C simus*. The true molars differ, as I have already pointed out, in their greater transverse diameter, and the greater anterior prolongation of the anterior horns of the posterior external crescents. The deep notch which is enclosed between this fold and the wall of the crescent in front of it is filled with cementum. As to the form of the true molars, the transverse diameter of the first considerably exceeds its anteroposterior diameter; in the *C. simus* the former diameter is equal to the latter In *C. emydinus* the last true molar is as wide as its length without the heel; in the *C simus*, the transverse diameter is much less In *C simus* the [illegible] is more prominent, and is recurved into a vertical ridge, which is wanting [illegible] in the *C emydinus*. In *C. emydinus* this tooth shows but little of the p[illegible]matic character, as the roots are of usual length.

The lower jaw of this species is not yet known.

Measurements.

	M
Length of skull along base	129
Length from condyles to posterior edge of zygomatic foramen	042
Length from condyles to palatonareal foramen	.063
" " " " line of last true molar	.071
" " occipital crests to line of orbits	.074
" " " " " facial vacuities	.084
" " " " " ascending process of maxillary bones	.115
Length from occipital crest to free end of nasal bones	.126
Elevation occiput, including condyles	.045
" of front at middle of orbit, without molars	.085
" " maxillary bone at P-m iii	015
" " " " " P-m. i	025
Width of skull at occipital condyles	.0675
" " " " superior edge of meatus auditorius	057
" " " " middle of zygomatic foramina	092
" " brain-case at middle of zygomatic foramina	029
" " skull at orbits	083
" " " between orbits	047
" " muzzle at superior edge of nares	.0215

Measurements. M.

Diameter external nares	vertical	.014
	transverse above	.017
Diameter of a facial vacuity	anteroposterior	.030
	tranverse	.013
Diameter of orbit	anteroposterior	.023
	vertical	.019
Diameter of zygomatic foramen	anteroposterior	.053
	transverse	.026
Diameter of foramen magnum	vertical	.0095
	transverse	.013
Diameter of meatus auditorius	vertical	.009
	anteroposterior	.011
Diameter of otic bulla	vertical	.025
	anteroposterior	.025
	transverse	.022
Width between canine teeth		.008
" " last true molars		.0285
Length of dental series		.065
" true molar series		.0343
" premolar		.0254
Diameters P-m. ii	anteroposterior	.0056
	transverse	.0050
Diameters P-m. iv	anteroposterior	.0070
	transverse	.0080
Diameters m. i	anteroposterior	.0075
	transverse	.0110
Diameters m. iii	anteroposterior	.017
	transverse (with external rib)	.012

The only specimen of this remarkable species known to me was found in the valley of Deep river, Montana, by my assistant, Mr. J. C. Isaac. The wear of the true molars shows that the animal was of full age, though not old.

PITHECISTES Cope.

Proceedings American Philosophical Society, 1877, p. 219.

This genus represents the final term in the decadence of the once powerful and numerous family of the Oreodontidæ. It is unfortunately established on a mandibular ramus only, and although some maxillary bones are referred to it with much probability, they are not preserved in such a way as to demonstrate the presence of the large nasal sinuses characteristic of Leptauchenia. I, however, suspect that they occur. The genus further resembles Leptauchenia in the coössification of the mandibular rami, and the reduction in number of the incisor teeth. In *P. brevifacies* there is but one inferior incisor tooth on each side. As reduction in the superior incisors usually precedes reduction in

those of the lower jaw, I suspect that the former were absolutely wanting in this genus. If so, we have in the Oreodont line the same process of reduction above, as has taken place in other lines of Artiodactyla at the latest or modern stage of their history.

In Pithecistes the inferior canine is caniniform, and masticated in contact with the superior canine, owing to the great abbreviation of the symphyseal region.

The diagnosis of the genus is as follows :

Inferior premolars three ; incisors one. Canine caniniform, masticating with the superior canine. No diastema. Symphysis coössified.

Two species are referred to this genus without conclusive evidence as to the number of their premolars. It is probable that they have but three, since their superior fourth premolars are of reduced size and incomplete type of form.

Pithecistes brevifacies Cope.

Proceedings American Philosophical Society, 1877, p. 219.

Ticholeptus beds of Deep river, Montana. Discovered by J. C. Isaac.

Pithecistes decedens Cope, sp. nov.

Established on a right maxillary bone, which contains the fourth premolar, the first and second true molars, and part of the alveolus of the third true molar. The last named tooth was not probably entirely protruded. This, with the moderate wear of the fourth premolar, indicates that the animal was fully grown, though young.

The species differs from all the members of the family whose dentition is known to me in the small size and simplicity of structure of the fourth premolar. The internal crescent of this tooth bounds only the posterior three-fourths of the external wall, and therefore leaves the anterior edge of the latter free. It is, moreover, not very convex, and its edge is not so elevated as is that of the external wall. The latter is flat on the external side, and its anterior marginal angle corresponds with the point of junction of the anterior extremity of the internal crescent. The true molars have the anterior horns of their crescents prominent, being sections of well-developed vertical columns. In this they differ from those of the *P. heterodon*, where these ridges are very weak.

The malar process of the maxillary bone is robust and prominent, and begins to expand opposite the first true molar. It presents a tuberosity downwards. The infraorbital foramen issues above the front part of the fourth premolar.

Measurements.		M.
Diameters P m. iv	anteroposterior	.006
	transverse	.005
Diameter m. i	anteroposterior	.0087
	transverse	.0077
Diameters m. ii	anteroposterior	.0115
	transverse	.006

Ticholeptus beds, Deep river, Montana. J. C. Isaac.

Pithecistes heterodon Cope.

Cyclopidius heterodon Cope, Proceeds. American Philos. Society, 1877, p. 22.

In this species the fourth premolar has the same form as in *P. decedens*, but the first true molar differs much in the more prismatic shape, and the absence of the external vertical ribs. It is quite possible that it does not belong to this genus.

Ticholeptus beds of Deep river, Montana. J. C. Isaac.

AGRIOCHŒRUS Leidy.

Proceedings Academy, Philadelphia, 1850, p. 121. Extinct Mammals Dakota and Nebraska, 1869, p. 131 (as family *Agriochœridæ*).

Orbit not closed behind. Fourth superior premolar with two external Vs. Fourth inferior premolar like true molars. Otic bulla inflated. Premaxillary bones distinct; no vacuities in the facial bones.

This genus commences cotemporaneously with the genus Oreodon, and persists longer, viz.: to the close of the John Day epoch. It represents a distinct line of succession from that which we have been considering, and one which contains but two known terms. Next to Agriochœrus comes, in this line, the genus Coloreodon Cope, which outlasted its predecessor so far as is yet known. It commenced with it in the John Day epoch, and continuing into the North Fork beds, which are of later age, did not appear later. This series Leidy regarded as a family distinct from the Oreodontidæ. For the present I prefer the view of Gill, that it constitutes a subfamily, the Agriochœrinæ.

This genus presents us with one of the very few cases in the suborder Artiodactyla, in which the last premolar approaches (above) or accomplishes (below) identity of structure with the true molars. This degree of complication was attained at the same period by both the equine and rhinocerontic lines of Perissodactyla, and all existing members of that order exhibit it. In the Agriochœridæ it made a beginning, but soon disappeared from the earth, and no Artiodactyle has developed such permanent premolars successfully since.

In the characters of the skull this genus is less robust than the Oreodontidæ; but the general skeleton remains unknown.

Five species have been described which are referable to this genus, and two others are now added. One of the former is without premaxillary or superior incisor teeth, and I therefore regarded it as representing a distinct genus under the name of *Merycopater*. It, however, appears that no specimens exist in our museums which exhibit this part of the skull in other species of the genus, so it is absolutely uncertain whether Agriochœrus possesses those teeth or not. The species may then be distinguished as follows:

I. Otic bullæ compressed, base anteroposteriorly ovoid.

a. Foramen infraorbitale above junction of P-m. iii and iv.

Front narrower; internal wall of fourth premolar not complete.......... ....*A. antiquus*
Front wider; skull shorter and higher, internal wall of inferior P-m. iv complete..................... ....*A latifrons.*
aa. Foramen infraorbitale above junction of P m ii and iii.
Front medially concave, laterally descending to orbits; sagittal crest short........... ....*A. trifrons.*
II. Otic bullæ mammiform with triangular base.
Front convex; nasal bones acute posteriorly; fourth inferior premolar complete; infraorbital foramen above junction of P-m. iii and iv .. ..*A. guyotianus.*
III. Otic bullæ oblong, constricted at the middle.
Infraorbital foramen above junction of P ms. ii and iii, front plane, nasal bones truncate posteriorly; postglenoid process robust...................................... .. . *A. ryderanus.*

Besides the above, Leidy has described an *A major** as near to the *A antiquus*, but of larger size. Marsh has described a small species from the Uinta formation under the name of *A pumilus.*† Lydekker figures and describes a superior molar tooth from India as probably belonging to this genus.‡ It is stated by him to have been found in the earlier pliocene formation. If this determination be correct, it represents the latest known species, as the *A. pumilus* of Marsh is the earliest. Owing to incompleteness in the descriptions of these species I cannot include them in the above synoptic table.

Agriochœrus antiquus Leidy.

Proceedings Academy Philadelphia, 1850, 121; 1853, 392; 1854, 157; 1857, 89, Ancient fauna of Nebraska, 1853, p. 24, Pl. I, figs. 5–10 Bronn Lethæa Geognostica, 1856, 933; Leidy Extinct Mammalia Dakota and Nebraska, 1869, 132, Pl. XIII, fig. 4.

White River epoch of Nebraska and Dakota.

Agriochœrus major Leidy.

Proceedings Academy Philadelphia, 1856, p 164, 1857, 89 ? *Eucrotaphus auritus* Leidy, Owen's Report Geological Survey, 1852, p 568, Pl. XV, figs 1 3. Ancient Fauna of Nebraska, 1853, p 56, Pl VII, figs 1 3 Bronn Lethæa Geognostica, 1856, 931.

White River formation of Dakota and Nebraska.

Agriochœrus latifrons Leidy

Proceedings Academy Philadelphia, 1867, p. 32. Extinct Mamm. Dakota, Nebraska, 1869, p. 135, Pl XIII, figs 1 3

White River epoch of Dakota and Nebraska.

*Extinct Mammalia of Dakota and Nebraska p 134.
†Amer Journal Science and Arts, 1875, p 250.
‡Paleontologica Indica.

riochœrus trifrons sp. nov.

'his species is known to me by a single cranium of an immature indi- ual. It lacks of perfection only the basioccipital, the pterygoid, and alveolar border of the premaxillary bones. It retains the third and rth deciduous premolars, while the third true molar is still in its alveo- , where it is exposed in place.

lthough the specimen is immature, its characters will not permit me to :e it with any other species known to me. I have specimens of like age he *A. guyotianus*, and these are quite different. From *A. ryderanus* ffers in the form of its otic bulla, etc.

ıe muzzle and front form a flat horizontal profile, while the parietal re- is convex. The profile descends gently to the supraoccipital border, ion. The muzzle is compressed above and below the canine alveolus, here is a concavity above the third and fourth premolars, and behind oramen infraorbitale above this fossa the lachrymal region is con- The nasal bones are lost, so that the form of their posterior suture ot be ascertained. The frontal bones are gently concave in transverse n between two lines produced forwards from the anterior extremities e temporal ridges, that is at the postorbital constriction of the cranium. e lines are represented by a rounded longitudinal angle, from which ontal bone descends to the superciliary border on each side. A trace is form is seen the *A. ryderanus*. The supraorbital borders diverge ards and backwards to the postorbital processes. These are prominent ontally, and are abruptly decurved at the apex. The temporal ridges se an urceolate area, having a gentle convexity in their direction be- hey unite at a point more posterior than in the other species, that is e a line connecting the anterior borders of the postglenoid processes. e malar bone is slightly concave on the external face, and is mode- y deep, and not thick. The squamosal part of the zygoma is rather er, and does not rise above the postglenoid process. Its superior edge nues without interruption into the posterior temporal crests, and so he supraoccipital. The postglenoid process is like that of *A. guyo- s*, narrow and produced downwards. Paroccipital lost. The otic is large, its anterior edge extending anterior to the postglenoid pro- It is nearly twice as large as in *M. guyotianus*, and extends much er forwards. It presents two flat sides, one external, the other out- s and forwards, and a convex side inwards and backwards. These meet at an angular edge below, which runs outwards and backwards. sphenoid bone is convex between the bullæ. Basioccipital lost. The onareal border is convex, and is opposite the middle of the second molar. In the mature skull it would be probably more posterior. The e is everywhere concave in transverse section.

e frontoparietal suture is broadly convex, and is opposite the anterior of the glenoid surface, and 25 mm. in advance of the sagittal crest. anterior processes of the bone on each side of the nasals are wide and cate, and do not extend beyond the interior suture of the lachrymal

bone. The latter is about as long on its superior sutures as it is deep at the orbit. It presents a distinct preorbital angle above a prominent tubercle. The occipito-pariëtal suture extends well forwards, 30 mm. in advance of the crest. The squamosal does not reach to the lateral occipital crest.

The infraorbital foramen occupies the position it has in the *A. rydersnus*. In a young specimen of *A. guyotianus* it has the same position as in the adult. The frontal foramina are about as far apart as each is from the supraorbital border. There is a postpariëtal foramen on the pariëto squamosal suture, and there are three postsquamosals, two of them near together, and near the posterior suture, the other below the postpariëtal foramen. *Foramen ovale* oval, about as large as the *F. rotundum*, and separated from the foramen lacerum by the produced base of the inferior ala of the sphenoid bone. Palatine foramen opposite the third deciduous premolar.

Superior canine teeth robust, bases of crown one-half lenticular, the posterior face truncate. A considerable diastema anterior to first premolar, and a short one behind it. Other teeth in continuous series. First and second premolars two-rooted; absolutely simple. Third and fourth crown of first of usual form. First true molar smaller than second. Enamel minutely roughened.

Measurements.	M.
Length from supraoccipital crest to canine inclusive	.180
" " " " " front of bulla	.036
" " " " " penultimate molar	.108
" " " " " orbit (axial)	.105
" " " " " front of orbit	.126
" of sagittal crest	.046
" " superior molars (last included)	.076
" " premolars	.036
Diameters M. i anteroposterior	.063
Diameters M. i transverse	.014
Diameters M. ii anteroposterior	.0165
Diameters M. ii transverse	.020
Width of skull at postglenoid inclusive	.077
" " " middle of zygomas	.050
" " " fundus of canine alveolus	.088
" between canines	.020
" " second true molars	.033
" of skull at postfrontal processes	.076
" " " between anterior rims of orbits	.066

The label from this specimen is lost. It is, however, from Oregon, and to judge from the color, from the true John Day epoch, rather than the North Fork bed.

Agriochœrus guyotianus Cope.

Hyopotamus guyotianus Cope, Proceedings American Philosophical Society, 1878, p. 77. *Merycopater guyotianus* Cope, American Naturalist, 1879, p. 197, Proceeds. Amer. Philos. Soc., 1879, 375.

Three crania, one with nearly entire mandible, and numerous fragments with mandibles, represent this species in my collection. It is the most abundant species of this genus in the John Day beds of Oregon.

The cranium is of peculiar form. It is elongate from the orbits backwards. The muzzle is elevated and compressed, so that the profile is horizontal, with subordinate irregularities. The occiput is therefore low as compared with the muzzle. The zygomata are rather slender, and are not expanded. The side of the muzzle is concave just below the superior border of the maxillary bone and above the fundus of the canine alveolus. The inferior part of the maxillary is concave from below the anterior border of the orbit to the line of the canine alveolus. The region above and anterior to the lachrymal bone is convex, leaving the flat nasal bones a little depressed. The frontal has a convex swelling on the middle line just posterior to the frontal foramina, from which point the surface slopes gradually and evenly to the supraorbital borders, and not in two planes, as in *A. trifrons*. At the front of the orbit the section of the frontal bone is convex at the sides and a little so at the middle. The supraorbital border is short and concave, not long and straight as in *A. trifrons*, and the postfrontal process is moderately prominent, and is not decurved. The anterior temporal ridges do not reach them. The former converge in nearly straight lines at an acute angle to a long sagittal crest. This in turn bifurcates into two very prominent posterior temporal crests, which overhang the occipital condyles. The brain-case is an elongate-oval, and the olfactory portion is long and narrow, but not especially constricted at any one point. There is a prominent small tuberosity at the inferior part of the lachrymal bone; above it the preorbital border is not defined as far as the beginning of the supraorbital. The postfrontal process originates below the anterior temporal surface which is continued along its posterior edge. The malar bone is concave on its external face. The zygoma is compressed, and has a long low superior convexity behind. Its crest continues into a fine, low, posttemporal crest, which turns posteriorly above to its prominent posterior expansion above mentioned. The latter turn outwards at the apices, and send a low ridge downwards towards the occipital condyle. Below, the latter form a low angle on each side, which separates a median from a lateral plane. Above, the occiput is deeply concave, and has a trace only of median keel.

The basicranial axis is flat and rather wide between the otic bullæ. The occipital condyles have distinct inferior boundaries which are separated by a flat interval. The posttympanic region is wide, and is bounded inferiorly by the deep styloid fossa. This is surrounded internally and posteriorly by the funnel-shaped base of the paroccipital process, which extends first posteriorly as a longitudinal lamina, and then outwardly. Its

edge terminates in a rough band which curves upwards and backwards to a point above the line of the occipital condyle. It is separated by a shallow groove from the corresponding posttympanic ridge. The tympanic bone is not so long as in the species of Oreodontinæ, and presents a tuberosity externally Like the paroccipital its base unites with the otic bulla. The bulla is small. Its base is extended towards the postglenoid process, but it is well separated from it, and does not reach the line of its anterior border. It presents a face anteriorly, and one inwards. The postglenoid process is narrow transversely, the depth and width being equal, and is elongate downwards.

The coronoid process of the mandible is short, but has a base extended anteroposteriorly. The articular face of the condyle is convex anteroposteriorly, and is extended downwards on the inner side behind. The horizontal ramus is slender, and has a straight inferior border (The angle is broken away from this specimen.) The symphysis is oblique and nearly straight in profile. It is moderately elongate, and has the suture persistent. There is a tuberosity looking downwards from its posterior extremity, where it is rounded-compressed

The facial part of the lachrymal bone is longer than deep, and the lateral anterior part of the frontal is wide and obtuse, and extends anterior to the lachrymal. The nasals extend posteriorly to terminate in an acute angle which is above the anterior edge of the orbit. The frontoparïetal suture extends across the space between the anterior temporal ridges at a point half way between the anterior border of the orbit and the anterior glenoid margin. The malomaxillary suture has no anteroinferior process. The mastoid forms a distinct mass between the exoccipital and squamosal. The sutures are largely coossified.

The infraorbital foramen is above the contact of the third and fourth premolars The space between the frontal foramina is about one sixth the interorbital width. There is a large postparïetal foramen on the parïeto-squamosal suture, and there are two small postsquamosal foramina, in line above the posttympanic tuberosity The mastoid foramen is small, and is not situated in a fossa of any extent, as is the case with the species of the Oreodontinæ. There is a large foramen intermediate in position between that of the anterior condyloid and the jugular. Anterior and a little external to it and slightly elevated between the confluent base of the paroccipital process and the otic bulla is another foramen, perhaps the jugular. Between the posterior base of the bulla and the basisphenoid, is a smaller foramen, probably the carotid. The other foramina are yet concealed by the matrix

The teeth do not differ in their form from those of other species of the genus The second and third premolars have triangular bases, the second the narrower. The first has two roots. It is accidentally lost from one side, which circumstance led me to suppose at one time that this species has but three premolars above. The fourth premolar has its posterior external V well developed, though a little smaller than the anterior. In the

specimen now described, the posterior internal rudimental cusp is quite well developed; in the two other specimens now before me it is not so large. The superior canine is elongate, and not very robust, and its convex anterior border is directed partly posteriorly at the apex. The enameled portion of the crown is quite short. The premaxillary bones are narrow and weak, and are separated so as not to be in contact on the middle line. Its border displays two minute alveoli, from which teeth have been shed. I do not suppose that their presence is constant in the species. The external alveolus is twice the diameter of the internal. The inferior incisors are of normal number, but are very narrow, and much crowded. The canines are very narrow, but are longer than the incisors. The first inferior premolar is more caniniform than in any other species of Oreodontidæ known to me. The crown is a compressed oval in section, and is not expanded at its base. It is enameled to within 5 mm. of the alveolar border. A considerable diastema separates it from the second premolar. The description of the remaining teeth I take from a separate ramus of similar dimensions, as they are concealed in the type by their position in juxtaposition with the cranium. The cusps of the true molars are pyramidal and acute, and entirely separate from each other. The external faces of the external are convex, their internal faces flat. The external faces of the internal are convex, the internal faces concave at the base, and convex near the apex. The anterointernal angle of the posteroexternal cusp extends to the base of the anterointernal cusp. The only difference between the first true molar and the fourth premolar, is that the anterior crest of the anteroexternal cusp is continued round to the front of the anterointernal cusp, and to the internal side of the crown; and the apices of the two anterior crests are separated by a shallow notch. The second inferior premolar has two roots. The heel of the third true molar is well developed, and is convex posteriorly.

Measurements.	M.
Length from occipital condyles to postglenoid process	.038
" " " " " preglenoid border	.058
" " " " " postfrontal process	.104
" " " " " canine, inclusive	.226
" " orbit to canine inclusive	.085
" of mandibular ramus from condyle	.176
" " symphysis mandibuli below	.049
Width of occipital condyles inclusive	.046
" " occiput above	.045
" " between otic bullæ	.016
" " at postglenoid processes inclusive	.079
" " of skull above glenoid surfaces	.100
" " " below orbits	.099
" " " between orbits	.068
" " " at fundus of canine alveoli	.040

Measurements.	M.
Width of skull between last upper molars, inclusive...	.070
Depth of occiput to foramen magnum................	.043
" " " " basioccipital bone................	.058
" " skull at last superior molar, exclusive........	.058
" " " " first premolar, exclusive............	.055
" " ramus mandibuli at front of M. iii...........	.035
" " " " " " " P-m. iv........	.027
" " zygomatic arch above glenoid facet...........	.027
Diameters of base of crown of superior canine { anteroposterior..........	.009
Diameters of base of crown of superior canine { transverse..............	.0065
Length of superior diastema.........................	.022
" " premolar series............................	.039
" " true molar series..........................	.043
Width of premaxillary bones together................	.043
Diameters of base crown inferior P-m. i; anteroposterior..	.0065
Length inferior diastema............................	.015
" " last three premolars..................	.031
" " true molars...........................	.046
" " last true molar.......................	.021
" " third premolar........................	.009
" " fourth................................	.012
Horizontal diameters of otic bulla { anteroposterior...	.019
Horizontal diameters of otic bulla { transverse........	.017

The specimens of this species which I have seen, are from the John Day river, and were obtained by Messrs. Sternberg, Wortman and Davis. The skull from which the above description was taken is the most perfect one of the genus Agriochœrus which has yet been found.

Agriochœrus ryderanus Cope.

Coloreodon ryderanus Cope, Bulletin U. S. Geological Survey Territories, vi, p. 173.

This species is represented in my collection by three nearly complete skulls without mandibular rami. While of the general size of the *A. guyotianus*, this species displays various well marked peculiarities. The most important of these are (1) the shape of the otic bulla, in which it differs from all other known Oreodontidæ; (2), the position of the infraorbital foramen, in which it resembles in this genus only the *A. trifrons*; (3), in the form of the nasal bones posteriorly, in which it differs from the species where this part is known; (4), in the form of the palatonareal border; (5), in the form of the postglenoid process; (6), in the outline of the section of the frontal bone.

Agriochœrus ryderanus has the muzzle compressed laterally and flattened on top, as seen in the *A. guyotianus* and *A. trifrons*, and the side of the

muzzle has three distinct fossæ. The largest of these is above the position of the fundus of the superior canine alveolus; the second is below the fundus, and the third is behind the position of the infraorbital foramen, and above the third and fourth premolars, and the first true molar. The lachrymal region is plane, and the nasals are flat. The frontal bone is nearly flat in section between the posterior borders of the orbits, but each is decurved to the lachrymal opposite the anterior border of the orbit. There is no indication of the three planes of the infraorbital region characteristic of the *A. trifrons*, nor of the median convexity of the *A. guyotianus*. The anterior temporal ridges commence about the middle of the width of each frontal bone, and unite after a shorter independent course than they have in *A. guyotianus* into a long, narrow saggital crest. This bifurcates posteriorly into two prominent lateral crests, which are directed downwards and soon terminate, but which send forwards and downwards a delicate posttemporal crest. This passes without interruption into the superior edge of the zygomatic arch. This arch is not expanded either upwards or laterally, and is rather weak. The external face of the malar bone is gently concave, and the inferior edge is rather wide, is truncate, and grooved along the middle. The occiput is deeply concave between the crests, and below them is gently convex. The superior edge of the foramen is deeply notched at the middle, much as in *M guyotianus*.

The occipital condyles are large, and their inferoanterior angles are produced horizontally for a short distance, forming short processes which are separated by a concavity of the basioccipital bone. The latter is plane below, but anteriorly develops a low meridian angle, which, widening on the sphenoid, causes its inferior face to be convex. The posttympanic element is distinguishable from the mastoid by a superficial groove, and a slightly free apex, and the mastoid from the paroccipital by a slight groove The external base of the paroccipital extends but 5 mm. external to the line of the external border of the occipital condyles, and is therefore much less prominent than in the majority of species of Oreodontinæ The base of the paroccipital has a posterior and an anterior face, nearly at right angles with each other. The latter is continued into the pinched posterior prominence of the auditory bulla, and encloses on its external side, with the apex of the posttympanic, the deep stylohyoid fossa The tympanic bone is represented by a tuberosity below the meatus, and a laminar expansion on the posterior face of the postglenoid process The otic bulla's long axis is inwards, and a little posterior from the internal side of the postglenoid process, from which it is separated by a narrow interval. The bulla is constructed at right angles to its long axis, in two parts. The external part is subglobular with the side next the postglenoid process flattened. The internal part is roughened, displays a flat side posterointernally, and has an apical keel which extends posteriorly and a little externally into the base of the paroccipital processes. This form is not known in any other species of the family. The postglenoid process is more robust than in either *M guyotianus* or *M. trifrons*. Its width and thickness are equal,

and are a good deal longer than its height; in the species named the height equals the other measurements. The pterygoid ala rises opposite the middle of the end of the glenoid surface, and the angle of its junction with the pyramidal process of the palatine is considerably in front of the middle of the trough of the posterior nares. Its edge posterior to this angle is shallowly grooved. The palatonareal border differs from that of any other species of the family known to me. It is acute in front, forming a Gothic arch, its apex being opposite the middle of the superior third true molar. In a young *M. guyotianus*, the only specimen of that species in which it is perfectly preserved, it is rounded, and extends to the posterior part of the second true molar. In an adult specimen, where the middle portion of the margin is lost, it extended at least as far forwards; but its form is uncertain. The palate in the *A. ryderanus* is strongly concave throughout.

The lachrymal bone has a different form from that of a *A. guyotianus*, more resembling that of *A. latidens* figured by Leidy. Its anterior superior angle is not produced, and its outline is a little deeper than long. The anterior lateral prolongation of the frontal extends beyond it by nearly its width, and is wide, and terminates in an obtuse angle. The posterior edge of the nasals is broadly rounded, truncate at the middle, and is situated much in advance of the frontal foramina. The pariëtal is in contact with the alisphenoid. The squamosal does not extend beyond the vertical line from the base of the paroccipital process.

The infraorbital foramen is above the anterior edge of the third superior premolar, a position only seen elsewhere in the genus *A. trifrons*. The superior border of the orbit is concave and short as in *A. guyotianus*, and not straight and flat as in *A. trifrons*. The frontal foramina are above their middle, and their distance apart goes 4.5 times into the interorbital width. There is a large postpariëtal foramen on the pariëtosquamosal suture, and a large postsquamosal immediately below it.. This arrangement differs from that seen in the other species here described, where there are two or three postsquamosals well posterior to the postpariëtal. Mastoid foramen small. There are two palatine foramina on each side of the mouth, one opposite the posterior edge of the second premolar, and one opposite the posterior part of the fourth premolar. The anterior condyloid foramen is large. On one side is a small posterior condyloid, the only occurrence I have met with in the family. The foramen lacerum posterius is not divided into three foramina as in the *A. guyotianus*, but remains open as in the species of *Eucrotaphus* and *Merycochœrus*. It shows its nearer affinity to the first named species, however, in its triradiate outline; and in the three grooves of the side of the bulla, which correspond to two of the three foramina. The *f. lacerum anterius* is not large, and is oblong in shape. The ovale is rather small, and is entirely bounded on the inner side by the pterygoid ala of the sphenoid. The *f. rotundum* is large and rather posterior. It is not bounded below by a transverse shoulder as is seen in the species of Merycochœrus, but is continued into a longitudinal groove, whose

external wall is longer than in any of the other genera of the family, extending to a point half-way between the inferior edge of the foramen and the middle of the last superior true molar tooth. It is curved both inwards and downwards just posterior to the foramen.

The superior molar teeth do not differ from those of *M. guyotianus*, *M. antiquus* and *M. latifrons*. The canines are very robust, and are separated from the first true molar by a considerable diastema.

Measurements.	M.
Length from occipital condyles to line of postglenoid processes	.046
Length from occipital condyles to line of preglenoid border	.060
Length from occipital condyles to line of postfrontal process	.110
Length from occipital condyles to line of canines, inclusive	.220
Length from orbit to canine inclusive	.076
Width of occipital condyles inclusive	.050
" " occiput at paroccipitals	.031
" between otic bullæ	.015
" at postglenoid processes inclusive	.093
" of skull above glenoid surfaces	.110
" " " below orbits	.094
" " " between orbits	.064
" " " at fundus of canine alveoli; about	.029
" " " between last upper molars, inclusive	.080
" " palate at second true molars	.033
" " " " third premolars	.031
" between superior canine	.021
Depth of occiput to foramen magnum	.038
" " " " basioccipital	.057
" " skull at last superior molar exclusive	.050
" " " " first premolar, exclusive	.046
" " zygomatic arch above glenoid facet	.021
Diameters base crown superior canine { anteroposterior	.014
Diameters base crown superior canine { transverse	.012
Length diastema to first premolar	.0185
" premolar series	.0365
" true molar series	.045
Diameters P-m. iv { anteroposterior	.011
Diameters P-m. iv { transverse	.014
Diameters M. i { anteroposterior	.014
Diameters M. i { transverse	.015
Diameters M. iii { anteroposterior	.018
Diameters M. iii { transverse	.021

The skulls of this species came from the John Day bed of the John Day river, Oregon, and were found by Mr. J. L. Wortman. The species was established on an immature individual. The adults show that it belongs to this genus.

COLOREODON Cope.

Proceedings American Philosophical Society, 1879, p. 375.

Superior premolars three, the fourth with two external Vs, no facial vacuities.

The mandibles of the species of this genus are unknown, so that the character of the inferior dentition is unknown. The otic bullæ are also destroyed in all the specimens, so that their character is unknown.

In its reduced dental formula this genus represents one stage of that specialization which Owen has shown, has overtaken all the modern types of Mammalia. In this series this process seems to have stopped at this point, and not to have gone further, as the entire line has come to an end.

The first superior premolar probably exists in a rudimental condition for a short time, and is early shed. The same state of things has been found to exist as an abnormality on one side in the *Agriochœrus guyotianus*, and may be found again, but not so as to invalidate the characters of the genus Coloreodon.

Two well-marked species of this genus have been described, which differ as follows:

Smaller; palatonareal border opposite posterior cusps of second true molar; sagittal crest anterior, commencing opposite optic foramina....................................... ....*C. ferox*.

Larger; palatonareal border opposite posterior cusps of third true molar; sagittal crest posterior, commencing opposite preglenoid border.................................*C. macrocephalus*.

Coloreodon ferox Cope. Fig. 1, p. 505.

Proceedings American Philosophical Society, 1879, p. 375.

The size of *Oreodon culbertsoni*. Known from one skull from the North Fork of the John Day river, Oregon. C. H. Sternberg.

Coloreodon macrocephalus Cope.

Proceedings American Philosophical Society, 1879, p. 376.

Size of the *Eucrotaphus major*. The typical skull is from the North Fork of the John Day river. A second skull, lacking all the parts posterior to the anterior origin of the sagittal crest, is undistinguishable from the first. It was found at the "Cove" of the John Day river, Oregon. Both were obtained by Mr. J. L. Wortman.

GENERAL CONCLUSIONS.

From what is now known of the history of the Oreodontidæ, the following conclusions may be drawn. These are especially instructive as far as they go, since they involve the causes of the rise, great development, decadence and extinction of one of the best-marked types of Mammalia the world has seen. The history of this type involves more or less the history of the life of the North American continent during the Miocene epoch of Tertiary time. It moreover involves the laws which regulate the vital success of all types of life, and which express the causes of multiplication, of energy, of weakness, and of sterility.

Two lines of the family, the *Oreodontinæ* and the *Agriochœrinæ*, come to light simultaneously in geological time, the White River epoch, or the Oligocene. The latter is a higher type than the former in its more complex fourth premolars, while it is inferior in the non-closure of the orbits posteriorly. It may then be regarded as a parallel line. It has but two generic types, while the Oreodontinæ present us with seven. So far as yet known, the Agriochœrinæ did not continue as long as the Oreodontinæ, as will be shown in tabular form below.

In the progressive modifications of the Oreodontinæ series, the first step was the inflation of the otic bulla (genus Eucrotaphus). This was succeeded by the coössification of the premaxillary bones (genus Merycochœrus). These changes were accompanied by a regular increase in dimensions. The species of Merycochœrus are all of the largest size, and there are no small ones. The smallest species of Eucrotaphus are equal to the largest ones of Oreodon. The fourth genus Merychyus, while it loses none of the points already gained, shows a deficiency in its facial walls where vacuities appear. There is the greatest range of size here : with one species (*M. major*), as large as any of the Merycochœri, we have another as large as the usual Eucrotaphi (*M. zygomaticus*), and several one degree smaller, or as large as the largest Oreodons. In the next genus the facial vacuities have attained to an enormous size. The premolar teeth become smaller, and the weakness of the narrow symphysis of the lower jaw is made up for by its coössification. The size is reduced from equal to the smallest Merychyi, to that of the smallest Oreodons (genus Leptauchenia). In the next stage (genus Cyclopidius) the superior incisors disappear. Finally, the lower jaw is so reduced in front that it loses both incisors and premolars, in spite of its symphyseal coössification (genus Pithecistes).

The species may be thus arranged in accordance with their distribution in time.

White River Epoch. Oreodon gracilis ; O. affinis ; O. culbertsoni. Eucrotaphus jacksoni ; E. major. Agriochœrus antiquus ; A. major ; A. latifrons.

John Day Epoch. Eucrotaphus jacksoni ; E. major. Merycochœrus superbus ; M. leidyi ; M. chelydra, sp. nov. ; M. macrostegus, sp. nov

Agriochœrus guyotianus; A. trifrons, sp nov.; A. ryderanus. Colore
macrocephalus

North Fork of John Day River Epoch. Eucrotaphus trigonocepla
sp nov., E major. Coloreodon ferox, C macrocephalus.

Ticholeptus Beds Merycochœrus montanus, sp. nov., M. rusticus
proprius. Merychyus arenarum, sp nov., M. pariogonus, sp nov.
zygomaticus Cyclopidius simus; C. emydinus, sp. nov. Leptaucl
major, L decora; L. nitida Pithecistes brevifacies; P. heterodon;
decedens, sp. nov.

Loup Fork Beds ? Merychyus elegans; M. medius, ? M. major.*

The stratigraphic relations of these species may be represented und
their generic heads in the following table:

	No of species	White River Epoch.	John Day Epoch.	? North Fork Epoch	Ticholeptus Epoch.	Loup Fork Epoch.
Oreodontinæ.						
Oreodon Leidy........	3	——				
Eucrotaphus Leidy...	3	——	——	——		
Merycochœrus Leidy..	7		——	——	——	
Merychyus Leidy....	6				——	——
Leptauchenia Leidy..	3				——	
Cyclopidius Cope......	2				——	
Pithecistes Cope.... ..	3				——	
Agriochœrinæ						
Agriochœrus Leidy....	6	——	——			
Coloreodon Cope......	2		——	——		
	35					

On the Structure of the Skull in the Elasmobranch genus Didymodus.

By E. D. Cope.

(*Read before the American Philosophical Society, March 7, 1884.*)

The genus *Diplodus* was described by Agassiz from specimens of teeth from the European Coal Measures. In America, Newberry and Worthen† have described four species from the Carboniferous of Illinois and Ohio; and I have reported two species from the Permian beds of Illinois and Texas. Recently Mr. Samuel Garman has described a shark, said to have been taken in the Japanese seas, under the name of *Chlamydoselachus*

* The questions refer to the geological age

† Geology of Illinois, vol. ii.

anguineus, whose teeth, as represented, do not differ generically from those of Diplodus. This is an interesting discovery, indicating that this genus, and not Ceratodus, is the oldest type of vertebrate now known in the living state.

My collections from the Permian beds of Texas include not only numerous teeth, but jaws and crania. Among these I recognize two types of teeth, which I cannot distinguish from those of the *D. compressus* Newb., and *D. gibbosus* Agass. Whether these species belong to the same genus, is a question which I will discuss at the close of this article. I provisionally refer the *D. compressus* to a distinct genus, Didymodus, and will so call it in this article.

The determination of the characters of this genus is a point of much interest The teeth resemble those of the existing sharks more than do those of any other genus of the Palæozoic ages, but the antecedent improbability of the modern type having existed at such an early period of the earth's history, is shown to be well founded by the present investigation, which also throws much light on the question of the general phylogeny of the fishes.

I. Description.

Twelve more or less complete crania of species of Didymodus are in my collection, and one set of jaws with small teeth and part of the cranium attached. One of the crania, unfortunately much broken, exhibits also some large teeth. All were found by the late Jacob Boll in the Permian beds of Texas.

The skull of this species forms a continuum, which, however, displays distinct segments. First, however, as to the tissue of which it is composed. Both on the surface and in transverse fractures, it is more or less finely granular, the granules distinctly visible to the naked eye. These granules are composed of gypsum, as is also the matrix of a darker color in which they lie imbedded. Two hypotheses may be entertained regarding this structure. *First*, These granules may be regarded as the casts of coarse cartilage cells, and the matrix be in the place of the intercellular cartilage, replaced like the woody tissue in petrified wood. *Second*, The granules may be looked upon as replacements of osseous granules, such as cover the chondrocranium of most Elasmobranch fishes, while the matrix may be a replacement of the cartilage. The latter hypothesis is the more probable of the two, for two reasons: First, There is little probability of an unsupported chondrocranium retaining its form sufficiently long to permit the filling of its cells with a mineral deposit. Second, The granular type of ossification is well known in existing Elasmobranchs. It is only necessary to believe that the chondrocranium is penetrated by this kind of ossification. This state of things exists in the jaws also, which I describe later. This structure has already been observed by Kner in the genus Pleuracanthus.

The osseous cranium is abbreviated anteriorly, and elongated posteriorly,

The orbit occupies part of the anterior third of the length. It is bounded in front by an obtuse preorbital process, and posteriorly by a laterally expanded and decurved postorbital process. The latter bears an articular facet on its posterior and inferior face. The top of the muzzle is excavated by a fontanelle which does not extend posterior to a line connecting the preorbital processes.

There is a prominent cup-shaped occipital condyle. On each side of the cranium a short distance anterior to it, is a prominent process extending outwards and a little backwards, which is excavated on its inferior side, but whose posterior side is decurved, so that the inferior concavity looks partially forwards. Into this cavity, and abutting against the decurved posterior edge, is a lateral process of the basal axial bone of the skull, which I take to be homologous with the lateral alæ which occupy the same position in the sharks. Anterior to this junction no doubt the hyomandibular bone was suspended, for I suspect that it was articulated to a small condyle which is wedged into the fissure between the inferior and superior elements described, a centimeter anterior to their posterior extremities. This condyle is a distinct element of a subglobular form.

The interorbital plane is continued posteriorly, bounded on each side by a depression which probably corresponds to the temporal fossa of higher vertebrates. The edges of this plane are thus well within the lateral borders of the cranium. The plane rises a little posteriorly, and is split into two narrow wedge-shaped processes, which project freely upwards and backwards. The rather short remaining part of the roof of the skull has a keel or sagittal crest on the middle line, which descends gradually to the foramen magnum.

The base of the skull forms a continuum from the edge of the large occipital cotylus to the acuminate anterior extremity. The lateral basal alæ are subcylindric, and are separated from the basicranial axis by a fissure for a short distance, and then unite with it. Two or three foramina anterior to this reunion, are in line with the defining fissure just mentioned. The basis cranii sends out a process on each side below the postorbital processes, giving a cross-shape to this part of the base of the skull. Anterior to this point it is free from other elements and contracts to an acuminate apex.

The cranium is segmented, but a clean specimen is necessary to permit the straight sutures to be seen. In the first place, there is a distinct occipital bone, which includes exoccipital and basioccipital elements combined. The latter includes the large occipital cotylus, as in the Rhachitomous batrachian Trimerorhachis, and differs from the structure seen in the Lepidosirenidæ, where exoccipital elements only are present. The occipital extends but a short distance on the inferior face of the axis. It is preceded directly, and without imbrication, by a continuous axial element. If we recognize in the granular character of the tissue evidence of true ossification of the chondrocranium, we have here true continuous sphenoid and presphenoid bones.

Returning to the superior face of the cranium, we observe that the exoccipital elements form a wedge-shaped body, divided on the middle line by suture, with the apex forwards. Traces of this division are figured by Gegenbaur as present in Heptanchus.* Anterior to this the middle of the cranial roof is apparently occupied by another triangular bone with the base posterior and the apex anterior, and concealed beneath the free extremity of the element in front of it. The lateral sutures only are distinguishable, appearing as grooves (fig. 2). This is the pariëtal bone. External to this and the occipital, and filling the space behind as well as anterior to the postero-lateral angle of the pariëtal, is the element which is produced outwards and backwards as already described. Were I describing a true fish, this bone might be intercalare (epiotic) or pterotic. Perhaps it is both combined, or it may be the cartilage bone called by Günther, in Ceratodus, the "tympanic lamina."† The element anterior to the pariëtal is the cartilaginous representative of the frontal, and the fact that it terminates posteriorly in two free processes is significant of the true homology of the bones which terminate in like manner in the crania of the Lepidosirenidæ.‡ In this family and in the Ceratodontidæ these bones are more or less separated on the middle line by the median posterior element. In Ceratodus the separation is wide; in Lepidosiren the interval is uninterrupted, but narrow in front. In Protopterus these elements are in contact on the middle line, but diverge posteriorly. Bischoff, Stannius§ and Günther identify these elements with the frontals in the genera they have described. Huxley‖ calls them supraorbitals, so that it becomes necessary to name the median posterior element a fronto-pariëtal, as a combination of two bones usually found distinct in fishes. The furcate structure of the frontal cartilage in Didymodus goes to show that the identification by Bischoff and Günther is the correct one. There are also in this genus distinct paired membrane bones which do not take part in the bifurcation in question, and which appear to represent the frontals of Ceratodus. Each of these is a flat, subcrescentic supraorbital plate, which has a concave superciliary border. It is separated by a considerable interval from its fellow of the opposite side. Its anterior extremity is notched by a fossa which I suppose to represent the anterior (posterior in position) nostril. The ? frontal of the right side is displaced, and appears as a lamina lying on the frontal cartilage, showing that it is a membrane bone. From its relation to the nostril the question arises, whether it be not the homologue of the nasal.

For hyomandibular bone, palatopterygoid arch, and mandibular arch, we have to rely principally on one specimen. On one of the skulls, two

* Ueber den Bau des Schedels der Selachier, 1872, Pl. I.

† Philosophical Transactions of the Royal Society, 1871, p. 511, indicated on the plates by the letter *d*.

‡ *Lepidosiren paradoxa* by Bischoff, Prof. in Heidelberg; Leipsic, 1840.

§ Handbuch der Anatomie der Wirbelthiere; Rostock; Erstes Buch, die Fische, 1854, p. 49.

‖ Anatomy of Vertebrated Animals, 1871, p. 145.

curved rib-like bones lie parallel and divergent posteriorly on the right side of the frontal, in the temporal fossa. I cannot identify them. They are not present on the opposite side. As already described, there is a facet on the infero-posterior face of the postfrontal process. This indicates the point of articulation of the palatopterygoid arch, as it exists in the group Opistharthri of the sharks as defined by Gill, and as is clearly proven by the specimen now to be described.

This includes the entire palatopterygoid and mandibular arches of one side, and the greater part of that of the opposite side, together with a considerable part of the right hyomandibular bone and probable extremity of the ceratohyal. The anterior parts of both jaws support numerous small teeth, which closely resemble those described by Agassiz as belonging to his *D. gibbosus*. They differ from those of the *D. compressus* in their smaller size. The palatine bones do not project much beyond the mandible, which, taken in connection with the form of the muzzle above described, renders it probable that the mouth was nearly terminal.

In the palatopterygoid arch there is no noticeable separation or suture between the palatine and pterygoid elements. The inferior border of the palatine is swollen below the orbit; its superior plate rises into a strong suborbital ala, which is concave externally, with thin superior edge. This edge rises posteriorly, giving the outline an elevated convexity, whose greatest upward prominence is above a point a little posterior to the middle of the jaw, and which probably articulated with the postorbital process of the cranium. Its surface gives indication of an articular surface appropriate to the corresponding one of the cranium. The superior border then descends rapidly to a vertical posterior border, which forms a somewhat prominent rim. This descends to the mandible, forming a regular ginglymus, the mandible bearing the cotylus. The mandible is rather robust; its inferior edge is rather thin, and becomes incurved anteriorly. Its superior border is regular, except that it rises a little at the coronoid region, and is impressed, corresponding with a concavity of the surface, and arch of the border of the pterygoid region, just anterior to the posterior prominent ridge which forms its posterior edge.

The hyomandibular bone is only exposed for its inferior half. It issues from behind the palatopterygoid as a narrow shaft with obliquely truncate extremity.

It is thus evident that the arrangement of the jaws is as in the two exceptional existing genera, Hexanchus and Heptanchus.

The external nostril already referred to, is a distinct, rather small fossa, on the lateral part of the superior face of the muzzle, near the extremity of the osseous portion. It is visible on both sides of the best-preserved specimen. It is continued forwards as a shallow groove. At the apex of the muzzle, is a fossa looking downwards, where roofed on each side by the ? nasal bones, which may represent the posterior nasal cavity. Or the latter may probably be represented by a lateral fossa just in front of the preorbital process. In either case it is evident that the nares are separated,

and that the posterior one cannot be said to be within the oral cavity, as is the case in the known families of the Dipnoi. It is probable that there is a frontoparietal foramen at the posterior bifurcation of the frontal bones, corresponding to the conarium or pineal body of the brain. In a cranium broken across just anterior to the bifurcation, a canal passing forwards and downwards is exposed. There is a foramen, or possibly only a deep fossa on each side of the middle line on the occipito-sphenoid suture. The foramen magnum is rather small and opens upwards. Its border displays no articular surfaces. At the middle of a line connecting the posterior borders of the postorbital processes is a small shallow fossa, or probably foramen, from this there extends on each side backwards and outwards, a shallow groove apparently for a vessel, which terminates at the anterior one of three foramina already mentioned as in line with the fissure which distinguishes the lateral ala of the basicranial axis posteriorly. A similar groove connects the first and second of these foramina, and in one specimen the groove from the median foramen joins this connecting groove. In front of the median foramen is a rather larger one on the median line, situated at the fundus of a short longitudinal groove. It is placed just posterior to a line connecting the preorbital processes. The grooves easily become obsolete by weathering.

II. Affinities.

In determining the systematic position of this animal, it will be convenient to take a survey of the characters of the primary divisions of the fishes. In 1840 Bischoff published the first account of the osteology of Lepidosiren. In this description he called the frontal bones malars with a question, and the pariëtals frontopariëtals. He described the skull as having an os quadratum. In 1854, Stannius in the Handbuch der Zoötomie* correctly determined the frontals and pariëtals, and stated further that the "lower jaw and hyoid bone articulate directly with continuous processes of the chondrocranium." This appears to be the first correct description of the cranial structure of the Dipnoi. In 1864,† Huxley restated the view of Stannius as to the nature of the mandibular articulation; adopted the opinion of Bischoff that the frontal is a frontopariëtal, and took a new position in calling the frontals supraorbitals. He also restates in general, the description of the skull of the Holocephali already given by Stannius.

The system of Johannes Müller, adopted by Stannius, was a great improvement over preceding ones. It embraced, however, the error of including the Holocephali in the same sub-class (Elasmobranchi) with the sharks. This was adopted by Gill in 1861,‡ by Huxley in 1864§ and in 1871.‖ All of these authors adopt at these dates the sub-class Ganoidea.

* Erstes Buch, die Fische, p. 49.
† Elements of Comparative Anatomy, p. 210.
‡ Catalogue of the Fishes of the East Coast of North America, p. 24.
§ Elements of Comparative Anatomy.
‖ The Anatomy of Vertebrated Animals, p. 120.

In 1871* the writer gave the following as the primary divisions of the sub-class Pisces: Holocephali, Selachi, Dipnoi, Crossopterygia, Actinopteri. The Holocephali was raised to an equivalency with the other sub-classes on account of the absence of distinct hyomandibular bone. The Dipnoi were defined by the median pelvic element, by the distichous arrangement of the segments of the pectoral and ventral fins, when present, on a median axis, and by the supposed presence of a distinct hyomandibular bone. The latter definition must be abandoned, for though an ossification exists, it has been shown by Stannius, Huxley and Günther, to be merely a deposit in the continuous chondrocranium. The sub-class Crossopterygia was substituted for the sub-class Ganoidea of Agassiz and Müller, as the latter was believed to have no actual existence as a division of fishes. After comparing the osteology of Polypterus, Lepidosteus and Amia, I remark (p. 320) "It is thus evident that the sub-class Ganoidea cannot be maintained. It cannot be even regarded as an order, since I will show that Lepidosteus, Accipenser, and Amia, are all representatives of distinct orders. I hope, also, to make it evident that Polypterus should be elevated to the rank of a sub-class or division of equal rank with the rest of the fishes and with the Dipnoi, already adopted." The sub-class Ganoidea has not yet fallen into disuse, but there are strong symptoms that it will do so.† Among others I select the following extract from Huxley's paper on the ovaries of the smelt, published in 1883.‡

"As is well known, Lepidosteus presents an example of a Ganoid with oviducts like those of the higher Teleostei; in *Osmerus*,* on the other hand, we have a Teleostean with oviducts like those of the ordinary Ganoidei. It is tolerably obvious, therefore, that the characters of the female reproductive organs can lend no support to any attempt to draw a sharp line of demarkation between the Ganoids and the Teleosteans.

"Boas has recently conclusively shown that the same is true of the supposed distinctive character afforded by the conus arteriosus; and it has long been admitted that the spiral valve which has been described in the intestine of *Chirocentrus* is the homologue of that which exists in all the Ganoids, though greatly reduced in *Lepidosteus*. Indeed I am inclined to believe that the circular valve which separates the colon from the rectum in the smelt is merely a last remainder of the spiral valve. Thus, among the supposed absolute distinctions between the Ganoids and the Teleostei, only the peculiarities of the brain, and especially the so-called chiasma of the optic nerves, remain for consideration. My lamented friend Mr. Balfour, in the last of his many valuable labors, proved conclusively that the brain of *Lepidosteus* is, both in structure and development, a Teleostean

* Proceedings Amer. Assoc. Adv. Science, p. 326. Transac. Amer. Philosoph. Soc., p. 419.

† The term ganoid can be used as an adjective to describe the scales already known by that name, and thus be preserved.

‡ Proceedings Zoölogical Society of London, 1883, pp. 137, 138, 139.

brain. But it is singular that no one, so far as I know, has insisted upon the fact, not only that the Teleostean brain is essentially similar to that of the Ganoids, but that it is exactly in those respects in which the Ganoids and Teleostei agree in cerebral structure that they differ most markedly from the Plagiostomi and Chimæroidei.

" With respect to the chiasma of the optic nerves, the exact nature of that structure has not yet been properly elucidated either in the Selachians or in the Ganoids. But, whatever may come of such an investigation, the establishment of the existence of a true chiasma in the Ganoids, and of its absence in Teleosteans, can have but little bearing on the question of their affinities, since Wiedersheim has shown that a simple decussation of the fibres of the optic nerves, as in ordinary Teleosteans, takes place in many lizards."

In 1877* I proposed the following primary divisions of the fishes, and have seen no reason to alter my views as to their value as a correct expression of the affinities and diversities of this class of Vertebrata. The system differs only from that of 1871 in the consolidation of the Crossopterygia and Actinopteri into a single sub class, the Hyopomata, and in a few corrections of the definitions given. They are as follows

I. Suspensorium continuous with the cartilaginous cranium, with no hyomandibular. No rudimental opercular bone, no maxillary arch, pelvic bones present; axial series of fore limb shortened, the derivative radii sessile on the basal pieces; axial series of hinder limb prolonged in male.. *Holocephali.*

II. Suspensorium articulated with the cranium; no maxillary arch; no opercular nor pelvic bones; bones of limbs as in the last........... *Elasmobranchi.*

III. Suspensorium rudimental, continuous with cranium, supporting one or more opercular bones; cranium with superior membrane bones; no maxillary arch, a median pelvic element, the limbs supported by segmented unmodified axes.............................. *Dipnoi.*

IV. Hyomandibular and palatoquadrate bones articulated with cranium, supporting opercular bones; a maxillary arch, no pelvic element, axes of the limbs shortened, the derivative radii sessile on the basal pieces.. *Hyopomata.*

In the definition of the Dipnoi, it is necessary to make the correction in accordance with the best observations on fresh specimens, above referred to, as I have not been able to determine the question from dried specimens in the Hyrtl collection The suspensorium cannot be properly said to be articulated to the cranium in the sense in which it is said to be such in the Elasmobranchi. In the latter it is articulated by ginglymus, in

* Proceedings of the American Philosophical Society, 1877, p. 25, and in the Annual Reports of the Commissioners of Fisheries of Pennsylvania for 1879-80, p. 67 and 1881-2, p. 111.

the Dipnoi merely by suture or contact, with other cartilage bones. Its character is therefore more nearly that of the Holocephali than of the Elasmobranchi or the Hyopomata.

In the light of the above considerations, to which sub-class must be referred the genus Didymodus? Does it possess a freely articulating hyomandibular bone, and maxillary, palatoquadrate and mandibular arches? The question must be primarily determined by these considerations, since the fins and their supports are unknown to us.

The lateral posterior processes of the skull are in its superior plane and their extremities do not present an articular facet for the lower jaw. It is improbable that they were continued downwards as cartilage for the former articulation, as in the Holocephali and Dipnoi. Both from the presence of an articular condyle, and from the mechanical necessities of the case, I have little doubt but that there was a freely articulating hyomandibular bone. I have already described this element in fact as visible in a single specimen. The choice is thus limited to the Elasmobranchi and Hyopomata. It is decided in favor of the former by the absence of maxillary arch and of opercular apparatus. So then Didymodus is a shark, in spite of its peculiarities. Kner* speaks of the presence in the nearly allied Pleuracanthus (= Diplodus), of premaxillary and maxillary bones, but this is no doubt a misinterpretation of the homologies, as he says they *articulate with the lower jaw*. In my jaws there is but one bone on each side, a palatopterygoid.

In his researches on the structure of the skulls of sharks, Gegenbaur† shows the different methods of articulation of the palatopterygoid arch in the sub-class Elasmobranchi. In Heterodontus the palatopterygoid arch is attached to the skull throughout by its superior border, anterior to the orbit, but is free posterior to the orbit. In Hexanchus and Heptanchus it is free anteriorly, but articulates by its elevated posterior portion with the postorbital process. In the remainder of known recent Elasmobranchs it is free throughout, and merely in contact in front. These relations are also described by Huxley.‡ Professor Gill utilizes them as definitions of three (of four) primary divisions of the sub-class Elasmobranchi,§ which he names the Opistharthri, (fam. Hexanchidæ); Proarthri (Heterodontidæ); Anarthi (sharks proper); and Rhinæ (Squatinas). According to these definitions, Didymodus must be referred to the Opistharthri. The skull, however, presents other characters which must claim attention. Its

* Sitzungsberichte Wiener Akademie, LV, p. 540.

† Untersuchungen zur Anatomie der Wirbelthiere, Leipzic, 1872.

‡ On the Anatomy of Ceratodus. Proceedings Zoöl. Society of London, 1876, p. 4-4, with figures.

§ Bulletin of the U. S. National Museum, No. 16, 1883, p. 967. Gill's fourth group, Rhinæ, does not appear to me to possess the value of the other three, nor are the "Raiæ" and "Pristes" more distinct. I therefore propose that the order Selachii, as defined in the following pages (of the sub-class Elasmobranchi), be divided into three sub-orders: Opistharthri, Proarthri and Anarthri, the latter to include the true sharks, the Squatinæ, the sawfishes and the rays.

reference to the Elasmobranchi is confirmed by the following characters: (1) The nares are not oral. (2) There is a large fontanelle on the summit of the muzzle. (3) There are processes corresponding to the lateral alæ of the basicranial axis.

In another character Didymodus differs from this and all other sub-classes of the Pisces. This is the penetration of the granular ossification throughout the chondrocranium.

In the following characters it agrees with the Dipnoi: (1) The distinct exoccipital, pariëtal, and frontal elements. (2) The occipital cotylus. (3) The posterior bifurcation of the frontal cartilage.

In the following characters Didymodus resembles the Hyopomatous or true fishes: (1) In the basioccipital bone with condyle. (2) In the ?os intercalare or pteroticum. (3) The presence of a distinct element articulating with the proximal end of the hyomandibular. (4) The presence of membrane bones in the position of frontals.

The characters above cited as constituting resemblances to the true fishes, will not, it appears to me, permit the reference of this genus to any of the divisions of sharks established by Prof. Gill. I therefore proposed a new order of the Elasmobranchi* for its reception, with the following name and definition.

A basioccipital bone and condyle. Occipital, ? pterotic, and frontal bones distinct. Supraorbital (or nasal) bones present............*Ichthyotomi.*

The remaining Elasmobranchi, in which the above characters are wanting, may be termed by way of contrast, utilizing an old name, *Selachii.*

Were it not for the probable presence of the free hyomandibular bone, the order Ichthyotomi might be regarded, in the absence of knowledge of its limbs, as the possible ancestor of the Rhachitomous Batrachia. But as the Batrachia have no distinct suspensorium, or are, to use Müller's convenient term, monimostylic, their origin must still be sought for in some yet undiscovered type of Dipnoi. It is on the other hand very probable that the Ichthyotomi are the group from which the Hyopomata derived their origin. The distinct basioccipital with its two foramina, the superior origin of the hyomandibular, and the superior nostrils, all point towards the true fishes. The tribe of Hyopomata which must be their most immediate descendents, are the Crossopterygia, as I define that division.

I must now compare the Ichthyotomi with such groups of the Hyopomata as they may be supposed to approach most closely. I begin by referring to the marine eels of the order Colocephali. In 1871† I characterized this order as follows: "Pariëtals largely in contact; opercular bones rudimental; the preoperculum generally wanting. Pterygoids rudimental or wanting; ethmoid very wide. Symplectic, maxillary, basal branchihyals, superior and inferior pharyngeal bones, all wanting, except the fourth pharyngeal. This is jaw-like, and is supported by a strong superior branchihyal; other superior branchihyals wanting or cartilaginous."

* American Naturalist, 1884, 413.

† Proceedings American Ass. Adv. Science, xx, pp. 328–334.

The statement "maxillary wanting," is in contradiction to the definition of the sub-class Hyopomata, which asserts the presence of those bones. Stannius* has asserted the absence of the "oberkiefer" in the eels. Gunther† describes their presence. As the absence of the maxillary bone would constitute a point of resemblance, if not affinity to the Elasmobranchi, I have reëxamined my material to determine the homologies of the lateral dentigerous bone of the upper jaw of the eels. My specimens of species of the Colocephali include the following from the Hyrtl collection: *Myrus vulgaris; Sphagebranchus rostratus; Moringua raitaborua; Muræna sp.; Muræna unicolor; Muræna sp.; Poecilophis polyzona*, and *Gymnomuræna tigrina*. The pterygoid bone exists in a rudimentary condition in the *Gymnomuræna tigrina*, *Myrus vulgaris*, and one of the species of Muræna; and whether lost in the preparation of the other crania or not, cannot be stated. In the *Anguilla vulgaris* the pterygoid bone is considerably larger, and extends to a point halfway between its base and the extremity of the muzzle. In the *Conger vulgaris* it extends still further forwards, reaching a transverse process of the anterior part of the vomer. No palatine bone appears. The premaxillary bone is not distinguished from the ethmoid in the Colocephali, nor in the Enchelycephali (Anguillidæ, etc.). It is quite possible, therefore, that the external dentigerous bone or upper jaw, in both of these orders, may be the palatine, and the maxillary be wanting. The family of the Mormyridæ appears to furnish the solution. In this group the structure and connections of the pterygoid bone are much as in Conger, and there are in addition distinct premaxillary and maxillary bones. It is clear that in this family it is the palatine, and not the maxillary bone, that is wanting. Similar evidence is furnished by the family Monopteridæ. The definition of all four of the orders, Colocephali, Enchelycephali, Ichthyocephali and Scyphophori must, therefore, embrace this character. The Gymnarchidæ agrees with the Mormyridæ in this respect, and both families have the transverse process of the vomer which receives the pterygoid, as in the genus Conger.‡ The supposed resemblance to the sharks presented by the Colocephali is then not real, and the question as to the point of affinity of the Ichthyotomi to the true fishes remains open as before.

I now refer to the remarkable characters presented by the deep sea fishes of the family Eurypharyngidæ, as recently published by Messrs. Gill and Ryder.§ These authors find the characters of the skeleton so remarkable, that they think it necessary to establish a new order for its reception, which they call the Lyomeri. The definition which they give is the following: "Fishes with five branchial arches (none modified as branchiostegal or pharyngeal) far behind the skull; an imperfectly ossified skull articulating with the first vertebra by a basioccipital condyle alone, only

* Handbuch der Zootomie, Fische 1854, p. 76.

† Catalogue Fishes, British Museum, vol. viii, p. 19.

‡ These transverse processes are enormously developed in Gymnarchus.

§ Proceedings U. S. National Museum, Nov. 1883, p. 262.

two cephalic arches, both freely movable; (1) an anterior dentigerous one—the palatine, and (2) the suspensorial, consisting of the hyomandibular and quadrate bones; without maxillary bones or distinct posterior bony elements to the mandible; with an imperfect scapular arch remote from the skull; and with separately ossified but imperfect vertebræ."

M. Vaillant came to no conclusion as to the affinities of this group; and Messrs. Gill and Ryder remark, "We are unable to appreciate any affinity of Gastrostomus to any Anacanthines, Physostomes, or typical Apods, nor does it seem to be at all related to Malacosteus, which has been universally considered to be a little modified Stomiatid." It is, however, clear to me that the relationships of this family Eurypharyngidæ are to the order Colocephali, and that they represent the extreme degree of the modification of structure which that order exhibits. In other words, the modification of the ordinary piscine type which is found in the Anguillidæ (order Enchelycephali), is carried to a higher degree in the Colocephali, and reaches its extreme in the Eurypharyngidæ. The points of identity between the two groups last-named are so many, that it becomes desirable to ascertain whether they are susceptible of ordinal separation from each other. The characters above given to the order Lyomeri are in fact identical with those which define the order Colocephali, with a few possible exceptions. First, however, I note that the supposed palatine arch, is probably the maxillary, as in the Colocephali, and that it is the palatopterygoid arch which is absent. The five branchial arches exist in the Colocephali, but the three anterior are rudimental, and the basal branchihyal bones of the fourth and fifth are closely united. There are, however, five arches. There is a ceratohyal arch in Muræna and Gymnomuræna, but of very slender proportions. Whether this element is absolutely wanting in Gastrostomus, or whether the first branchial arch is its homologue, remains to be ascertained. Should the last two be coherent as in the Colocephali, we would then have the same number of hyoid arches in both, viz., six. The "imperfectly ossified cranium" is shown in the detailed description given by Messrs. Gill and Ryder, to support the same bones which are found in the Murænoid skull. The degree of ossification of the skeleton does not constitute a basis for ordinal distinction, if the same elements be present. For this reason the perforation of the vertebral centra by the remnant of the chorda dorsalis does not seem to be of ordinal importance.

In the more detailed description, there are a few charecters worthy of notice. First, "The notochord is persistent in the skull for half the length of the basioccipital." This indicates further the primitive condition of the vertebral column, but scarcely gives basis for an ordinal definition. Second (p. 266.), "The neurapophyses are slender, diverging (instead of convergent), cartilaginous distally, and embracing the neural sheaths on the sides, while by the neurapophyses is supported a membranous sheath which roofs over the nervous cord," etc. The nerual canal is well closed above in the Murænidæ, but in the Anguillidæ it is largely

open above. The neurapophyses it is true unite, but at a distance above the neural cord, and as attenuated rods. Third, "There is no vomer developed, but a triangular cartilaginous element pendent from the cranial rostrum affords attachment for the palatine (read maxillary) elements anteriorly," etc. This element probably exists in the Colocephali and similarly takes the place of the vomer, only differing in being ossified. I have been accustomed to regard it as the homologue of the bone called ethmoid in fishes.

The character which distinguishes the Colocephali from the Enchelycephali, now that their maxillary and palatine structure are shown to be essentially the same, is found in the hyoid apparatus. In the Enchelycephali, the structure is as in ordinary fishes; there is a glossohyal, and there are basihyals, and axial branchihyals, and superior pharyngeals. In the Colocephali all these elements are wanting, excepting the fourth superior pharyngeal, which has the form of an antero posteriorly placed dentigerous jaw, which opposes the lateral branchihyal of the fifth arch or, as it is generally called, the inferior pharyngeal. It is evident that the Eurypharyngidæ are more similar to the Colocephali than to any other order in this respect also, but the description of these parts is not yet sufficiently detailed to enable me to determine what difference there may be in this respect, if any. The mobility of the quadrate bone on the hyomandibular cannot be regarded as of great systematic significance, although it is doubtless important in the economy of the fish

It is then evident that the Eurypharyngidæ belong very near to, if not within, the order Colocephali. Towards the end of their description, Messrs. Gill and Ryder (p. 270), recognize this relationship, but deny that it indicates that this family is "from the same primitive stock as the Murænids." I incline to the belief that it is the ultimate result of the line of development of which the Anguillidæ form one of the first terms, and the Murænidæ a later and more specialized one.

It is therefore clear that the point of relationship of the Ichthyotomi to the true fishes is not to be found in the Eurypharyngidæ or the Colocephali.

In the following point Didymodus resembles Polypterus. The fossa above described as on each side of the basioccipital, is found in Polypterus. There it serves as a place of insertion of a strong ligament on each side, which is attached externally to the epiclavicle, and serves to hold the scapular arch in its place. A similar structure exists in the Siluridæ, where the ligaments are ossified. It suggests for Didymodus a scapular arch suspended more anteriorly than in sharks, possibly even to the skull.

The genealogy of the fishes will then be as follows, first, however, it is to be understood that in asserting the derivations of one group from another, I mean that in accordance with the rule which I have termed "the doctrine of the unspecialized," the later type in each case is the descendant of the primitive and not the later sub-form of its predecessor. In this way is to be explained the apparent anomaly of regarding the

notochordal sturgeons as descendants of Crossopterygia, whose modern representatives are osseous. The primitive Crossopterygia, and probably even the Actinopteri, were doubtless as cartilaginous as are the existing sturgeons:

Hyopomata = { Actinopteri, Chondrostei, Crossopterygia. } — Batrachia.

Elasmobranchi = { Ichthyotomi, Selachii. } — Dipnoi.

Holocephali.

In this phylogeny, the Holocephali, which have not differentiated a suspensorium, are regarded as the primitive fishes, although the living representatives display some specialized characters, as, for instance, a membranous gill-cover which conceals the primitive slits. The line to the right continues the monimostylic character and passes into the reptiles, whose primitive types are also monimostylic, as Johannes Muller called them. In the later forms or streptostylicate reptiles of Muller (Lacertilia, Ophidia), the quadrate becomes freely articulated.*

In the left hand series, the Elasmobranchs immediately present us with the free suspensorium or hyomandibular, which is a well-known character of the remainder of the line, the modifications being the addition of separate elements, as the metapterygoid, "quadrate," and symplectic.

The penetration of ossification into the chondrocranium of Didymodus, in regions not ossified in either fishes or batrachia (sphenoid and presphenoid), and into regions not ossified in any vertebrate (frontal and parietal cartilages), may be, so to speak, only a local phenomenon, and not indicative of extensive phylogenetic consequences. For if it be so regarded, it evidently proves too much, giving affinities in the base of the skull to the reptiles, and in the roof exhibiting a character more highly developed than any known form of vertebrata.

The Ichthyotomi include, so far as yet known, but one family, the Hybodontidæ of Agassiz. According to that author this family includes four genera, Hybodus, Pleuracanthus, Cladodus and Sphenonchus. It ranges from the coal measures to the Jura inclusive.

The genus Didymodus may be described as follows:

Frontal plane well defined on each side by the temporal fossæ, and terminating in two cornua posteriorly. Anterior nares on the superior surface of the muzzle. Supraorbital (or nasal) bones well separated on the median line and constituting the only membrane ossification. Teeth with large lateral denticles.

The species *Didymodus compressus* Newberry, may be defined as follows:

Skull with massive walls. Form elongate, depressed, the orbit not ex-

* The phylogeny of the Reptilian series can be found in the Proceedings American Association Advancement of Science, xix, 1871, p. 233. The Batrachia are supposed to be their ancestors.

tending behind the anterior third of the length. Basicranial and basifacia[illegible]acial axes in one line, flattened, the supraorbital border flat, concave on th[illegible] the edge, postorbital processes obtuse, the temporal ridges commencing wit[illegible]with thin posterior border, which they excavate. The ridges then turn, ex[illegible] tend parallel posteriorly, terminating in the horn like processes alread[illegible] described, with a slight divergence. The apices mark the posterior thir[illegible] of the length of the skull. The occipital condyle is wider than deep, an[illegible] its superior border retreats forwards so as to cause its cup to look upward[illegible] The exoccipital diameter at the foramen magnum is less than that of th[illegible] basicranial axis, the osseous element of which, probably sphenoid, is re[illegible] curved on the sides to their middle. The sides of the latter expand a[illegible] little to meet their lateral alæ. Immediately above their contact is situ[illegible]ated the supposed condyle for the hyomandibular element. The basicrania[illegible] axis is convex opposite the postorbital processes, from the bases of which[illegible] a concavity separates it. It has a slight median groove at this point. It[illegible] is much narrower than the interorbital width above. A short distance in[illegible] front of the postorbital processes it begins to contract, and gradually[illegible] reaches an acuminate apex. Superior to this apex, commencing posterior[illegible] to it, the space between it and the supraorbital or nasal elements is occu-[illegible] pied by a massive element (? ethmoid) which forms the floor of the nasal [illegible] median fontanelle.

The surfaces are smooth, but readily weather so as to be granular. The [illegible] granules are subround, with flattened surface.

Measurements of skull.

	M.
Total length of skull to end of frontal bone (No. 1) . . .	180
" " " muzzle to orbit, axial	.024
" " " skull to postorbital process	.058
" " " " to apices of frontal cartilage	117
" " " " to ? pterotic apex axial	.155
Width of skull at prefontals	045
" " " " supraorbital borders	.055
" " " " ? pterotic apices	088
" " occipital condyle	.034
Depth " " "	025

Measurements of jaws.

Length of mandibular ramus from cotylus, inclusive.	.145
Depth " mandibular ramus at cotylus	028
" " " " " middle	.035
Length " palatopterygoid bone from cotylus, inclusive.	145
Depth " " " at postorbital articulation	.071
Depth of palatopterygoid bone at orbit	.035
Length " " " posterior to orbit	.070

A second species has been brought to light by the researches of Mr. W.

F. Cummins in the Permian beds of Texas. Parts of the jaws with two of its teeth are preserved. The lower jaw is distinguished from that of the *D. compressus* by its small transverse as compared with its other diameters. The ramus is quite compressed, and is not thicker at the inferior edge than the superior, and is slightly concave on the inner side. Its external face is nearly vertical. The angle is rounded forwards, and there is no angle behind the cotylus, which is raised above the superior line of the ramus. The cotylus is rather large, and has a shallow anterior superior, and a posterior subposterior facet. There is no indication of a coronoid process. The inferior edge of the ramus is swollen on the outer side, below the anterior border of the condyle, so as to mark with the thickened posterior edge of the ramus a fossa in the position of the masseteric.

The teeth are pecular in the form of the root (Figs. 8–9). This part has no anterior projection, and the posterior portion is a flat, thin-edged plate, wider than long. It carries a button, but no notch. There is a minute median denticle. The form of the root is thus very different from that of the tooth of the *D. compressus* (figs. 5, 7).

Measurements.		M.
Depth of ramus at cotylus (vertical)		.062
" " " 120 mm. anterior to cotylus		.048
Transverse diameter at the same point		.009
Long diameter (oblique) of cotylus		.031
Diameters of base of tooth	anteroposterior	.011
	transverse	. 37
Diameters of crown of lateral denticle	anteroposterior	.0048
	transverse	.006

I call this species *Didymodus platypternus*. Should the name Didymodus be found hereafter to apply to species of Pleuracanthus, the latter generic name must be used for this species.

III. Historical.

In 1837 Prof. Agassiz (Poiss. foss., iii, 66), described a spine which he believed to have belonged to a fish like the sting-rays, as *Pleuracanthus lævissimus*. The only example was obtained from the Dudley Coal field.

In 1845 Prof. Agassiz (Poiss. foss., iii, 204), made known certain teeth, which he referred to sharks of the family of Hybodonts. Two species were distinguished, *D. gibbosus* and *D. minutus*. Both were obtained from the English Coal measures.

In 1848 Prof. Beyrich (Berichte vernandl. k. Preuss. Akad. wiss., 1848), proposed the generic name Xenacanthus for a German Carboniferous form, referred to Orthacanthus by Goldfuss (1847), but which approached nearer to Pleuracanthus.

In 1849 Dr. Jordan (Jahrbuch für Min. u. Geol., p. 843), described, under the name *Triodus sessilis*, a form subsequently ascertained to be identical with the Xenacanthus.

In 1857 Sir Philip de Malpas Gray Egerton (Ann. and Mag. Nat. His xx, 423), contended that the spines of Pleuracanthus belonged to the same fish as the Diplodus teeth, and that Xenacanthus was likewise referable to the same type.

In 1867 Prof. Kner (Sitzb. k. Akad. wiss. Wien, lv, 540–584), published a memoir, illustrated by ten plates, in which he proved that Diplodus and Xenacanthus were generically identical.

In 1875 Messrs. St. John and Worthen proposed the genus Thrinacodus for the *Diplodus incurvus* and *D. duplicatus* of Newberry and Worthen and the *T. nanus* St. J and W., from Illinois.

In 1883, in the Proceedings of the Philadelphia Academy (p. 108), I proposed the name Didymodus for the *Diplodus compressus* Newberry.

In Science for 1884, p. 274 (March 7th), I called attention to the close resemblance of the teeth of this genus to those of the recent shark, called by Garman Chlamydoselachus, and expressed my belief in the identity of the two genera.

In the American Naturalist for April, 1884, p. 413, I gave a brief abstract of the characters of the skull of Didymodus, and proposed to regard it as the type of a new order to be called the Ichthyotomi.

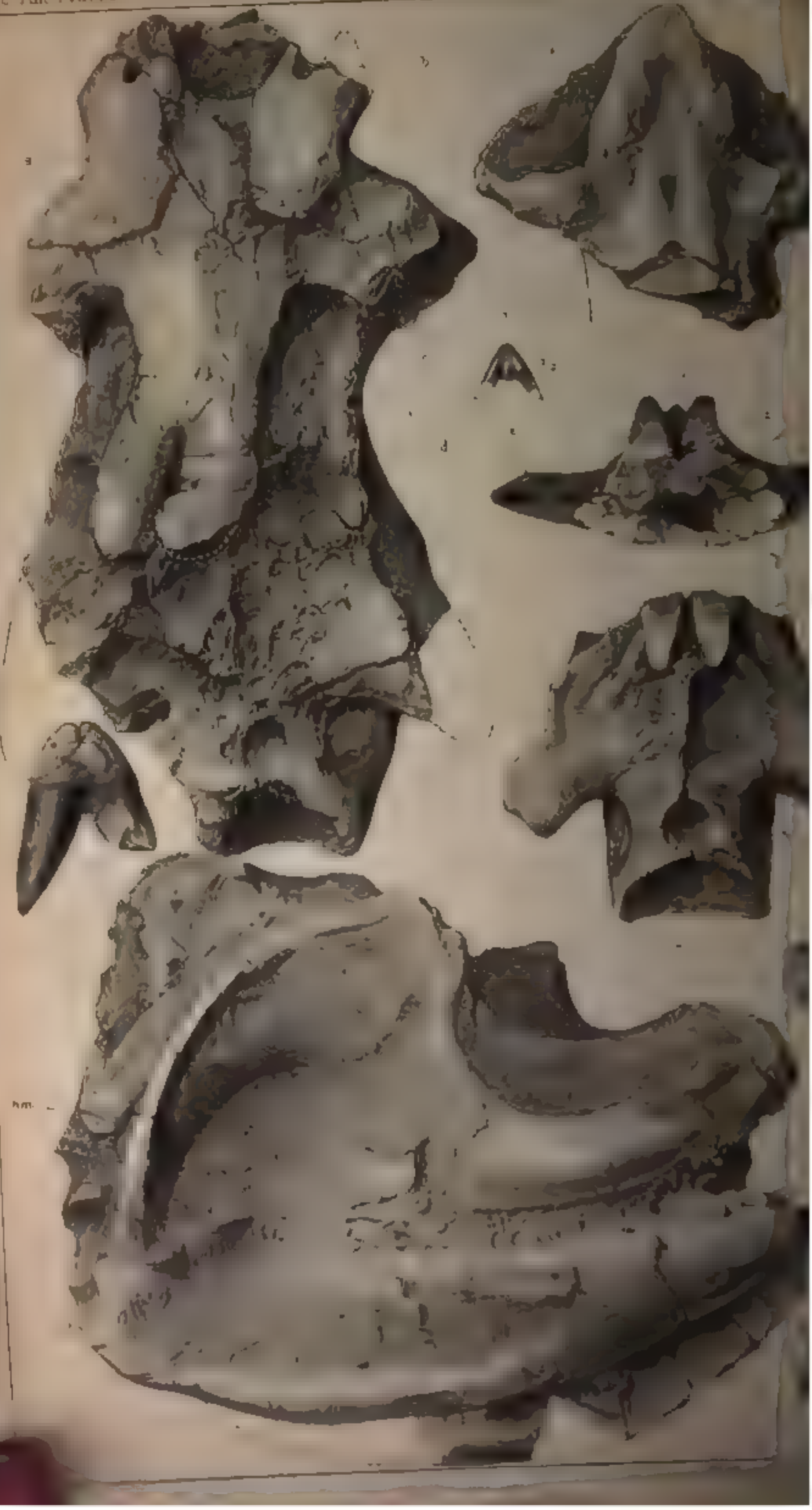
In Science, 1884, p. 429 (April 11), Prof. Gill objects to the identification of the genera Didymodus and Chlamydoselachus, on the ground of the different forms of the teeth. He states that he doubts the pertinence of the two genera to the same order. He points out that the oldest name for Diplodus Ag. is Pleuracanthus Ag., and that the order Ichthyotomi had been already defined and named by Lutken, with the name Xenacanthini.

On these various propositions the following remarks may be made.

(1.) There is no generic difference to be detected, in my opinion, between the teeth which are typical of Diplodus Agass. and Thrinacodus St. J. and W. and the recent Chlamydoselachus. Differences there are, but apparently not of generic value. The identification of the recent and extinct genera rests, as far as this point goes, on the same basis as that of the recent and extinct Ceratodus.

(2.) At the time of my proposal of the name Didymodus, I was not convinced that fishes of this type bore the spines referred to the genus Pleuracanthus Ag. None of the authors cited figure any specimens which present both tricuspidate teeth and a nuchal spine. None of my ten specimens possess a spine. However, Kner describes two specimens as exhibiting both tricuspidate teeth and a spine, and Sir P. Egerton's statements (*l. c.*), on this point are positive. So we must regard Pleuracanthus as the name of this genus, with Diplodus as a synonym.

(3.) Diplodus being regarded as a synomym of Pleuracanthus, it follows that Chlamydoselachus Garm. is distinct, on account of the *different structure of the dorsal fin*, which is single and elongate in Pleuracanthus, according to Geinitz and Kner. The presence of the nuchal spine in Pleuracanthus is also probably a character of distinction, although we do not yet know whether such a spine is concealed in Chlamydoselachus or not.



(4.) The identity of Didymodus (type *Diplodus compressus* Newberry) and Pleuracanthus, may now be questioned. None of the specimens are figured and described by the authors above cited, as displaying an occipital condyle, or posterior frontal cornua. My specimens of *Didymodus compressus* do not exhibit teeth on the roof of the mouth, as Kner describes. There are no spines with the crania, although separate Pleuracanthus spines are not rare in the same beds. The teeth associated with the skulls, moreover, present a button on the superior side of the root (Fig. 5). Agassiz figures teeth of this kind as belonging to the *Diplodus gibbosus*. St. John and Worthen make these teeth typical of Diplodus, and confer the name Thrinacodus on those without the button, a character which I do not think a constant one. The latter name is then probably a synonym of Pleuracanthus. The button-bearing teeth are figured and described by Kner as occurring scattered, and in a somewhat different horizon from that of the Pleuracanthus specimens. In Germany, as in Texas, the button-bearing teeth are the larger. I suspect that the skull I have described represents a different genus from Pleuracanthus proper. This genus will not differ from Chlamydoselachus Garm., in the lack of other evidence; the teeth presenting only specific difference.

(5.) Of course, a study of the anatomy of Chlamydoselachus, which I hope Mr. Garman will soon give us, may reveal differences between that genus and *Didymodus*; but of these we know nothing as yet.

(6.) The order Xenacanthini was proposed by Geinitz (Dyas) for Pleuracanthus, on account of the supposed suctorial character of the ventral fins. This character is supposed by Kner to be sexual. In any case this division, whatever its value, must be subordinated to the order Ichthyotomi, as I define it.

EXPLANATION OF PLATE.

All the figures two-thirds natural size, except fig. 6, which is one-half larger than nature.

Fig. 1. Skull from above, right frontal bone displaced, and its anterior extremity broken off. Posterior apex broken from right frontal cartilage bone. *a*, Frontal or supraorbital bone, that of the right side displaced; *b*, anterior nostril; *c*, postfrontal facet for palatopterygoid; *d*, frontal fissure.

Fig. 2. Posterior part of skull of another individual, from above; *a*, occipital bone; *b*, pariëtal; *c*, a cornua of frontal bone.

Fig. 3. Anterior view of fig. 2, displaying section of brain case; *a*, frontal or pariëtal cartilage bone; *b*, sphenoid; *c*, brain cavity; *d*, frontopariëtal fontanelle; *e*, hyomandibular condyle (? pterotic bone).

Fig. 4. Anterior part of skull from below, of a third individual, displaying orbits and postorbital processes.

Fig. 5. Tooth of *Didymodus compressus* Newb., natural size, posterior view.

FIG. 6. Palatopterygoid and mandibular arches of a fourth individual from right side, with *hm*, hyomandibular.

FIG. 7. Superior tooth of external row, without apices of two of the cusps ; from the palatine bone of the specimen represented in fig. 5 ; one-half larger than nature, anterior view.

FIG. 8. Tooth of *Didymodus platypternus* Cope, nat. size, from above posteriorly.

FIG. 9. Tooth of a second specimen of *Didymodus platypternus* from below.

Photodynamic Notes, IX. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, April 18, 1884.)

411. *Æthereal Oscillation.*

Some readers of the Photodynamic Notes have found a difficulty in applying the laws of pendulum oscillation to the undulations of the luminiferous æther. It is well to guard against the conception of material pendulums, hung in or across the solar system, but it is also well to remember that the modern theories of molecular motion explain the rigidity of steel, and of all other solids, by the rapidity of motion, in ultimate discrete particles. If this view is correct, all changes in molecular movement are probably transmitted in and through the same elastic medium as the undulations of light, and all oscillations are in some way dependent on æthereal oscillations.

412. *Illustrations of Nodal Tendency.*

The well-known experiments of placing bits of paper on vibrating strings, sprinkling sand on Chladni plates, depositing fine powders in transparent musical tubes, and eliciting musical notes from glass vessels which are partly filled with water, illustrate the tendency of all vibrations to drive material particles towards musical nodes. These nodes are subject to the same laws of inertia which determine centres of oscillation in ordinary pendulums. The nodal tendency is greatest where the relative elasticity and the consequent undulatory velocity are greatest. As we know of no other medium in which the ratio of elasticity to density is so great as in the luminiferous æther, we can reasonably look in no other direction for such striking evidences of rhythmic influence as are to be found in cosmical and molecular arrangements.

413. *Æthereal Rotation.*

The supposed properties of the luminiferous æther are so similar, in many respects, to those of ordinary gases, that we may suppose it to act and react on all grosser forms and aggregations of matter. The rotations and revolutions of suns, planets and satellites are not only in harmony

with æthereal undulations, but they are also, as we may reasonably presume, produced by them. If cosmical rotation is dependent, in any way, upon æthereal waves, the reaction of cosmical inertia should produce a tendency to æthereal rotation.

414. *Extent of Rotating Influence.*

It is not unreasonable to suppose that the tendency to æthereal rotation at stellar centres, may be felt at a distance which is at least as great as the modulus of light. That distance in our system is very nearly equivalent to seventy-four times Neptune's mean radius vector. Although the rigidity in a rotating æthereal sphere may seem to be of a very different character from the rigidity of metallic rods and cosmical globes, it must evidently be accompanied by similar tendencies towards gravitating and oscillatory centres.

415. *Kinetic Postulates.*

All modern researches which have been guided by the theory of universal kinetic correlation seem to justify the following postulates:

1. An all-pervading, elastic æthereal medium, the particles of which are subject to gravitating attraction.
2. Consequent cyclic, rhythmic and harmonic tendencies of various kinds.
3. Probable frequency of simple forms of harmony, which are governed by centres of oscillation.
4. Mutual and equal action and reaction between centripetal gravitation and centrifugal radiation.
5. Radiating as well as projectile velocities, which are measured by the sum of cyclical resistances.
6. Correlation and mutual convertibility of light, heat, electricity, gravitation, etc.
7. Tendency of harmonic approximations to become numerically exact, as demonstrated by Laplace in discussing the motions and orbital periods of Jupiter's satellites.

416. *Importance of Reciprocals.*

In some text-books on arithmetic, a few lines are given to the explanation of reciprocals, and the statement is sometimes added, that the reciprocals of an arithmetical progression constitute a harmonic progression. Few, except those who devote themselves to a thorough scientific study of music, ever get any further knowledge of a subject which is full of interest, and which is likely to become of great importance in the future annals of scientific research. In his pamphlet on "Electrical Units of Measurement," Sir William Thomson enlarges upon the want of a unit of conductivity to represent "the reciprocal of the resistances." He says: "It is the conductivity that you want to measure, but the idea is too puzzling; and yet, for some cases, the conductivity system is immensely superior in accuracy and convenience to that by adding resistances in series."

417. *A Universal Want.*

Electricity is the form of force which is now, for many practical reasons, commanding general attention ; but its need of a more satisfactory and systematic study of reciprocal and harmonic activities is no greater than we can find in many other fields of physical research. Ohm's law brings all electrical phenomena so directly within the realm of resistance that Maxwell was inclined to regard electro-dynamics as more fundamental than thermo-dynamics. A full consideration of the subject would require a knowledge of mathematical principles which are somewhat intricate. There are many facts, however, which are so simple and intelligible that they may be easily learned, and a knowledge of them may awaken an interest which will facilitate investigation in every possible field.

418. *Spheral Music.*

We have all heard of the "music of the spheres ;" how many of us understand the literal truth of the statement :

> "There's not the smallest orb which thou behold'st,
> But in his motion like an angel sings."

The music of the spheres, as well as the music of the human voice, or of stringed or brazen instruments, is due to elasticity, which makes successive vibrations follow regular laws, so as to produce rhythmical and pleasing results. The beats of pendulums are governed by some of these harmonic laws and may be represented by harmonic formulas. The luminiferous æther, which is supposed to pervade all planetary and interstellar spaces, and which Newton suggested as the possible storehouse of gravitation, should, on account of its enormous elasticity, furnish endless illustrations of faultless rhythm.

419. *Confirmation of the Hypothesis.*

We find, in accordance with the foregoing note, that the resistance of the sun to the interstellar vibrations of light produces a series of twenty-seven musical nodes, within the region in which solar attraction predominates over the attraction of the stars. Nine of the nodes are between Mercury and the Sun ; nine are at points which account for the positions of the eight primary planets and of the asteroidal belt ; and nine are between Neptune and the nearest of the fixed stars. The middle node of the middle nine, or the fourteenth node of the twenty-seven, is in the asteroidal belt. These facts, which have been already given in previous notes, are repeated in this connection as indicative of the probability that the æthereal rotation extends much further than was intimated in Note 414, and as giving the most stupendous evidence which has ever been published of the nodal tendencies to which reference is made in Note 411.

420. *Revelation.*

The foundation of all knowledge is revelation, which is always self-evident and infallible. The inspiration of the Almighty giveth understanding. All that we have and all that we are come from Him. In the interpretations of revelation, we are left in some measure to ourselves. While the self-evidence is given to us, we combine, in various ways, premises which we accept on account of their self-evidence or supposed self-evidence; in that combination we are liable to mistakes and fallacies of judgment. All truth is God's, all error is man's. They therefore make a fatal mistake who would set up the decisions of fallible judgment against the revelations which are offered for the acceptance of their own faith, or those which have been clearly apprehended through the faith of others, in truths which have been made self-evident to them.

421. *Fallacy of Agnosticism.*

We have no right to question the assertion of any individual that he does not know God. Neither has any one a right to say that God is unknowable. Receptivity, power, and knowledge, are the three fundamental axioms of all science and of all truth. So far as either of them is finite it is dependent upon something superior to itself. The agnostic, who recognizes a Supreme Power and who fails also to recognize a Supreme Receptivity and a Supreme Wisdom, has but a partial view. If in his teachings he implies, in any way, that human receptivity or human wisdom can be superior to any other receptivity or wisdom, he is guilty of arrogance and cannot shield himself under any assumption of humility. The only power of which we have any practical knowledge, is that of will; and will itself is always directed by purpose. So far as man, through the exercise of his purpose, his will and his intelligence, controls the powers of nature, he is imitating the Supreme control. Although it is true that we cannot "find out the Almighty unto perfection," and although it is also true that we should avoid any narrow anthropomorphism, there is no doubt that the purpose, the will, and the wisdom of man differ from those of the Almighty, not in kind, but only in degree, and that in these respects man has been created in the image of his Maker.

422. *The Oxygen Unit.*

Marignac (*Ann. de Chim. et de Phys.*, March, 1884), in his late re-examination of some of the atomic weights, considers that Prout's law is only approximate, and that, since the numbers which express the atomic weights only represent ratios, there is no reason for taking the hydrogen unit in preference to 16 or 100; but the choice of 16 is justified by its practical advantage. It allows us to represent the atomic weights of the greatest number of elements, and especially of those which are most important, by the most simple possible integers and with the least difference from the rigorous results of experiment. The fact that the atomic weights exhibit

more exact ratios to the oxygen than to the hydrogen unit, appears to have been first pointed out in No. 138 of the foregoing notes.

423. *Universal Rotation.*

The hypothesis that every material particle is endowed with rotation, by which it represents a definite amount of living force, has often been broached. Its probability is strengthened by the magnetic theories* of Arago, Ampére, Barlow, Lecount, Challis, Babbage, Herschel, Christie, Maxwell, Imray, Forbes and others; by my own investigations confirmatory of the hypothesis that "there can be no weight without some degree of momentum;"† by the connection of magnetism with rotation in a magnetic field through Laplace's principle of periodicity (note 338); and by the evidences which are furnished, by notes 413 and 419, of interstellar æthereal rotation, producing nodes which are determined by stellar moduli of light. According to this hypothesis no material particle can be wholly divested of energy, and no particle can ever acquire energy enough to free it from the equilibrating tendencies which spring from the law of equal action and reaction.

424. *Nascent Nebular Rotation.*

The beginning of the transfer of rotation from æthereal particles to cosmical masses, is illustrated by the equivalence of ratios between masses and rupturing distances, in the two ruling globes of the solar system. Taking Bessel's estimate of the mass-ratio of Sun to Jupiter (1047.879), the vector-radii of the two bodies, when in static equilibrium with regard to their common centre of gravity, should be in the same ratio. The projectile energy, which changed the static into an oscillatory dynamic equilibrium, has produced a secular eccentricity, according to Stockwell, of .0608274, the secular perihelion being, therefore, .9391726 of Jupiter's mean radius vector. Dividing the static ratio of vector radii, 1047.879, by .9391726, we get 1115.7469 × Sun's semi-diameter for Jupiter's mean radius vector. Dividing this value by 5.202798, we get 214.4513 for Earth's mean radius vector, which represents a mean solar apparent semi-diameter of 961''.8254. The British Nautical Almanac estimate is 961''.83.

425. *Nascent Resistance.*

Laplace's principle of periodicity, and incipient "subsidence," according to Herschel's modification of the nebular hypothesis, are both exemplified in the equation:

$$(1 - e)\, g_5 t_5 = \sqrt{g_0\, r_0}$$

in which e = Jupiter's secular eccentricity; g_0, g_5 = gravitating acceleration at the equatorial surface of Sun and Jupiter, respectively; t_5 = time

* Cited in Proc. Amer. Phil. Soc., ix, 356–8, 367–9, 491; Proc. Roy. Soc., xxii, 352–3, etc.

† Proc. Amer. Phil. Soc., ix, 357, 492.

of Jupiter's half rotation = 17863.25 sec.; r_0 = Sun's semi-diameter. Hence $\sqrt{g_0 r_0} = 2\pi \times 214.4513^{\frac{3}{2}} r_0 \div 31558149 = .0006252614\, r_0$.

$$g_0 = .0000003909518\, r_0$$
$$g_5 = .00000003727\, r_0 = .09533064\, g_0$$
$$r_5 = .10005233\, r_0$$

426. *Nascent Centre of Condensation.*

The incipient subsidence of Jupiter, as indicated by the factor $(1 - e)\, g_5$, coöperates with solar attraction in the formation of a belt of maximum condensation. Accordingly, the second planetary mass, in regard to the simplicity of harmonic relations, is Earth, which occupies the centre of the dense belt. Its distance from the Sun and its mass may be found by means of the equation

$$\sqrt{(1 - e)\, g_5 r_5} = (\rho_5 \div \rho_3) \sqrt{g_3 r_3}$$

The mean radius vector is designated by ρ, Jupiter and Earth being indicated by subscript $_5$ and $_3$ respectively. We have, therefore,

$$g_3 = .00607723 \text{ miles}$$
$$r_3 = 3962.8 \text{ miles}$$
$$\sqrt{g_3 r_3} = 4.90743 \text{ miles}$$
$$\rho_5 \div \rho_3 = 5.202798$$
$$\sqrt{(1 - e)\, g_5 r_5} = .09464615 \sqrt{g_0 r_0} = .0000591786\, r_0$$
$$r_0 = 431445.64 \text{ miles}$$
$$\rho_3 = 214.4513\, r_0 = 92524100 \text{ miles.}$$
$$\sqrt{g_0 r_0} = 269.766 \text{ miles}$$
$$m_0 \div m_3 = 328997$$
$$r_5 = 10.893\, r_3$$

427. *Nascent Nodal Harmonies.*

The formation of a belt of maximum condensation, by the action and reaction of subsidence and rotation between the two principal masses of the system, establishes the conditions which are requisite for nodal harmonies of various kinds. One of the simplest harmonic series is $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{3}$, etc. The centre of linear oscillation adds its influence to the natural rhythmic tendencies of the second of these nodes. Both the moment of rotary inertia of a thin spherical shell and the nodes of aggregating collision in condensing nebulæ* also introduce the factor $\frac{2}{3}$, and the moment of a rotating æthereal or other homogeneous sphere introduces the factor $\frac{2}{5}$. Moments of inertia vary as distances of projection against uniform resistance; we may, accordingly, look for the frequent recurrence of the factors $\frac{2}{3}$ and $\frac{2}{5}$, in the harmonic rupturing nodes of condensing and rotating nebulæ, especially in the neighborhood of the most important centres of condensation.

* Proc. Am. Phil. Soc., xvii, 99.

428. *The Sun-Earth Balance.*

The situation of Earth's orbit, between the orbit of Jupiter and the Sun, introduces tendencies to condensation and rotation of the character referred to in the foregoing note. The action and reaction of æthereal waves, between the principal centres of attraction and of condensation, have produced an amount of gravitation, at the earth's equatorial surface, which is sufficient to give a circular orbital velocity of $\sqrt{gr} = 4.90748$ miles per second. The linear oscillation of the Earth around the Sun, as well as the centre of rotary inertia for a superficial film of condensation or of luminous undulation in the orbit of Mars, multiplies this energy by $\frac{3}{2}$; the rotary æthereal oscillation of a sphere which has its limit in the asteroidal belt also multiplies the energy by $\frac{5}{2}$. Accordingly, if the Earth's orbit was always circular, its velocity of revolution, as thus determined, would be $\frac{5}{2} \times \frac{3}{2} \times 4.90748 = 18.40286$ miles per second. There are 31558149 seconds in a year, therefore the Sun's distance should be, if Earth's orbit were always circular, $18.40286 \times 31558149 \div 2\pi = 92430800$ miles. This is probably correct within less than $\frac{1}{8}$ of one per cent. (See Note 434.)

429. *Accuracy of Harmonic Method.*

The above method of estimating the Sun's distance is the shortest which has ever been published. I believe that it is also the most accurate if proper allowance is made for orbital eccentricity, for the following reasons:

1. If the hypothesis of an all pervading luminiferous æther is true, all its cyclical movements must be rhythmic, or harmonic, the various forms of rhythm being governed by various centres of oscillation.
2. The simplest kinds of oscillatory motion, in cosmical bodies, are linear and spherical.
3. Laplace showed, in discussing the motions of Jupiter's satellites, that whenever there are tendencies to simple numerical relations, in planetary arrangements, all the forces of the system combine to make those tendencies exact.
4. The Sun is the principal centre of attraction, and the Earth is the principal centre of condensation in the solar system.

430. *Rhythmic Weight of the Sun.*

The Sun can be weighed by its musical rhythm with a corresponding facility. Orbital velocities vary inversely as the square root of the distance from the centre of gravity. Any two attracting bodies bear the same ratio to each other as the distances at which they would communicate equal orbital velocities, to particles which revolve about the centre of gravity of the attracting bodies. Hence we have:

Earth's Radius Vector.		Earth's Radius.		
$92430800 \times (\frac{5}{2} \times \frac{3}{2})^2$	:	3962.8	: :	328002 : 1.

In other words the Sun would weigh 328002 times as much as the Earth, if Earth's orbit were always circular.* The remarkable accordances among the various harmonic estimates which are deduced from the correlations of mechanical, electrical, chemical, luminous and other forces, indicate an amount of probable error which is much smaller than those of ordinary astronomical estimates.

431. *Lunar Mass. First Estimate.*

Ferrel (*Methods and Results*, p. 20) gives 7989 metres as the height of the homogeneous atmosphere. The equilibrium of atmospheric elasticity, between the mutual interactions of Earth and Moon (Notes 8, 316), gives the following proportion:

$$(20000000 \div \pi) : 7989 : : r_3 : .0012549 r_3 : : (\pi^2 \times 80.74) : 1$$

432. *Lunar Mass. Second Estimate.*

The estimates of the height of a homogeneous atmosphere differ for different latitudes and for slight variations in the elements of the calculation. It may, therefore, be more satisfactory to deduce the Moon's mass from the simple principles of oscillation.

From Notes 8, 162, 246, we find:

$$l = g\left(\frac{t}{\pi}\right)^2 = \frac{32.08776}{5280} \times (43082.04)^2 \div \pi^2 = 1142874 \text{ miles}$$

for the length of Earth's theoretical pendulum. From this equation we deduce the ratio of Earth's mass (m_3) to Moon's mass (μ), by the proportion:

$$\rho_3 : l : : m_3 : \mu.$$
$$92524100 : 1142874 : : 80.957 : 1$$

433. *Earth's Secular Eccentricity.*

The harmonic relations of the Earth and Moon are still further shown by the evidences of original terrestrial projection before the Moon separated from the Earth. If we designate Earth's secular perihelion radius vector by ρ'_3, we have the proportion, $g_0 \, r_0 \, (m_3 + \mu) : (g_3 \, t_3)^2 m_3 : : \rho_3 : \rho'_3$.

In other words, the orbital vis viva of original solar projection, for the combined masses of Earth and Moon, is represented by the mean radius vector, while the limiting oscillatory vis viva of the Earth alone is represented by the radius vector of secular perihelion. Substituting in the above proportion the harmonic values which we have already found, we have

$$269.766^2 \times 81.957 : 261.8194^2 \times 80.957 : : 1 : .930462$$

this gives, for Earth's secular eccentricity, .069538.

Stockwell's estimate of this eccentricity for the value of Earth's mass which we have deduced from its harmonic oscillation is .06901. The dif-

* See Note 434.

ference between his perihelion radius vector and the corresponding harmonic radius is less than $\frac{1}{17}$ of one per cent.

434. *Correction for Secular Eccentricity.*

In Note 428, Sun's distance was estimated upon the hypothesis that Earth's orbit was circular. The mean distance, however, may be considered as having been established at the time of original rupturing projection, or, in other words, at secular perihelion. The circumference of an ellipse is $2\pi a \left(1 - \frac{1}{2^2} e^2 - \frac{1^2.3}{2^2.4^2} e^4 - \frac{1^2\,3^2.5}{2^2.4^2.6^2} e^6, \text{etc}\right)$

Substituting the theoretical value $e = .06954$, this becomes $2\pi a \times .99879$. The corresponding value of Earth's mean radius vector is $92430800 \div .99879 = 92542790$, which differs by less than $\frac{1}{17}$ of one per cent. from the value which was deduced in Note 426, from the incipient subsidence of Jupiter. The corresponding value of $m_0 \div m_3$ is 329196

435. *Twin Planets.*

Action and reaction, in a system which is fundamentally dependent upon two largely preponderating bodies, may naturally lead to a grouping in pairs. Laplace's modification of the nebular hypothesis, which supposes that the first ruptures are in the form of rings or belts, and Herschel's hypothesis of subsidence until the acquired velocity becomes rupturing, also favor the simultaneous formation of companion perihelion and aphelion planets Accordingly, we find two supra-asteroidal groups, Neptune-Uranus, Jupiter-Saturn, and two infra-asteroidal, Mars-Mercury, Earth-Venus. The grouping in the belt of greatest condensation indicates a double tendency, Earth-Venus representing influences which appear to have originated in the Sun, while Mars-Mercury seem to be more specially referable to activities at the centre of condensation, than to those at the centre of nucleation.

436. *Mass Relation of Jupiter and Saturn.*

The discovery, by Prof. Stephen Alexander, that the masses of Jupiter and Saturn are nearly in the inverse ratio of the squares of their mean vector radii, was the first step towards a demonstration of the fundamental principles of harmonic astronomy This ratio represents the moments of æthereal or nebular rotary inertia for the two planets, respectively. The closeness of the approximation is shown by the proportion

$$5.202798^2 : 9.53852^2 :: 104.879 : 3522.3.$$

Hall's estimate of Sun $\div$ by Saturn is 3482; Bessel's 3501.6, Leverrier's 3512. The greatest difference between either of these estimates and Alexander's approximation is only about $1\frac{1}{4}$ per cent, the least difference is less than $\frac{1}{2}$ of one per cent I know of no other mass-approximations which rest upon purely rhythmical laws, except my own.

437. *Mass-Relation of Earth and Venus.*

The simplicity of the harmonic mass-relations between Sun and Earth, as well as between Jupiter and Saturn, increases the likelihood of similar relations, which are equally simple, between Earth and Venus; but the wide range of discrepancy among the estimates of different astronomers makes it somewhat difficult to ascertain what rhythmic influence has prevailed. Stockwell's estimate of Venus's mass is about .945 of Earth's mass; Hill's is only .831; Leverrier's mean of two estimates, .872. The value which would give Earth and Venus equal orbital momenta is .85049. We may, therefore, claim a great probability for the proportion, $m_0 : m_2 : : (329196 \div .85049 = 387066) : 1$.

438. *Mass-Relation of Neptune and Uranus.*

In the exterior twin planet belt, we find a harmonic mass relation which is no less striking than those that have already been given. It is especially interesting, as pointing to an early stage of nebular condensation, as well as to a blending of external and internal influences which accounts for retrograde satellite rotation and revolution. The gravitating accelerations, which are due to the actions and reactions between two cosmical masses, are proportioned to the respective masses. The vis viva of gravitating subsidence $\left(\frac{m v^2}{2}\right)$ is, therefore, proportioned to the cube of the masses. We find, accordingly, that

$$m_8^3 : m_7^3 : : \rho_8' : \rho_7.$$

In this proportion ρ_8' represents the locus of incipient subsidence, or secular aphelion of Neptune, while ρ_7 represents the mean radius vector of Uranus. The values which satisfy this proportion are very exact, as will be seen by the following comparison:

	Harmonic.	Newcomb.
Sun ÷ Neptune	19372.86	19380 ± 70
Sun ÷ Uranus	22603.33	22600 ± 100

439. *Mass-Relation of Mars and Mercury.*

The Earth appears to have exercised an influence upon the two exterior planets of the belt of greatest condensation, analogous to that which the Sun has exercised upon Neptune and Uranus. We find, accordingly,

$$m_4^3 : m_1^3 : : \rho_4 : \rho_1.$$

In this proportion, if we let ρ_4 and ρ_1 represent the mean distances of Mars and Mercury, respectively, the mass of Mars would be 1.5789 times that of Mercury. Adopting Hall's estimate of Sun ÷ Mars = 3093500, we find Sun ÷ Mercury = 4884366. Encke's estimate is 4865751. These estimates are based upon the hypothesis that Sun ÷ Earth = 354936. If we substitute the harmonic value, 329196, we get Sun ÷ Mars = 2869151; Sun ÷ Mercury = 4530150.

440. *Linkage of Earth and Neptune.*

It was shown in Note 428 that Earth's mass may be harmonically deduced from Sun's mass through its limiting value of circular orbital velocity. Neptune's mass may be deduced from Earth's through the corresponding limit of orbital time. We have, accordingly, $m_8 : m_3 :: t_a : t_\beta :: 16.98 : 1$. In this proportion $t_a = 2\pi \sqrt{\frac{r}{g}}$; t_β = a sidereal day.

441. *Earth's Oblateness.*

The importance of Earth's position, at the centre of the belt of greatest condensation, is further shown by the fact that its centrifugal force of daily rotation, by which it is harmonically connected with Neptune, has also determined its oblateness For we find that $(t_a \div t_\beta)^2 = 288.4$. Listing's estimate (See Note 249) is 288.5.

442. *Linkage of Earth and Uranus.*

Another interesting connection between the dense belt and the outer twin-planet belt, is shown by the proportion, $365.2565 : 338.2183 :: \rho_7' : \rho_7$. In this proportion, 338.2183 is the distance, measured in Earth's semidiameters, at which a satellite particle would revolve in a solar year; ρ_7' is the secular aphelion distance of Uranus, while ρ_7 is its mean distance. This relation is also interesting because the aphelion of the 33.25 year meteoric belt is in the orbit of Uranus, and because a ray of light would traverse the same meteoric orbit in the time of one solar rotation The proportion gives, for the secular aphelion of Uranus, 1.07994. Stockwell's estimate is 1.07797.

443. *Another Linkage of Earth and Jupiter.*

In notes 425 and 426, the gravitating accelerations of Earth and Jupiter were shown to be harmonically related to each other, as well as to the gravitating acceleration of the Sun. The moon furnishes another harmonic link, which is shown by the equation

$$60.2778 \times 5.202798 \times 1047.879 = 328629$$

In this equation 60.2778 is von Littrow's estimate of Moon's mean distance in equatorial semidiameters of the Earth; 5.202798 is Jupiter's mean distance, in Earth's mean vector radii, 1047.879 is the quotient of Sun's mass by Jupiter's mass, 328629 is, within less than $\frac{1}{4}$ of one per cent, the harmonic quotient of Sun's mass by Earth's mass.

444. *The Meteoric Theory of World Building.*

Proctor (*North American Review*, May, 1884) criticises the theory of Olbers, which has been lately advocated by Herbert Spencer, and considers that the asteroidal belt has been formed by meteoric influence, in connection with the attraction of Jupiter, rather than by the explosion of any primitive planet. In many of the foregoing notes there has been evidence

of influences which may be regarded as meteoric. Indeed, Herschel's subsidence-theory recognizes the continual activity of such influences, provided we consider every particle which is falling towards the sun as meteoric. If we still further regard the luminiferous æther as material, we may consider ourselves as living in a condensing and rotating nebula.

445. *Linkage of Sun, Earth, Jupiter and Saturn.*

The influence of simple primitive subsidence, which was so strikingly exemplified in the mass ratios of Neptune and Uranus (Note 438), is no less evident in the four important cosmical bodies which represent, respectively, the chief centre of nucleation (Sun), the chief centre of condensation (Earth), the primitive nebular centre (Jupiter), and the centre of inertia of the primitive planetary system (Saturn). This influence is shown by the equation

$$\text{Sun} \times \text{Earth} \times \text{Saturn} = \text{Jupiter}^3.$$

Substituting in this equation the harmonic ratio of Sun to Earth (329196) and Bessel's estimate of Sun ÷ Saturn (3501.6), we get for Sun ÷ Jupiter 1048.5.

446. *Saturn's Secular Eccentricity.*

The mutual actions and reactions, among the four cosmical masses which were introduced into the foregoing note, are still further shown by the connection of the orbital periods of Earth and Jupiter with the secular eccentricity of Saturn.

This connection is shown by the proportion

$$4332.5848 : 365.2565 :: 1 : .0843045.$$

Stockwell's estimate of Saturn's secular eccentricity is .0843289.

This differs by less than $\frac{1}{34}$ of one per cent from the harmonic estimate.

447. *Primitive Phyllotactic Relations.*

The centre of a nebula which is bounded at opposite extremities of its diameter by the secular aphelia, or loci of incipient subsidence, of Neptune and Uranus, according to Stockwell's estimate, is 4.8952. This differs by less than $\frac{1}{3}$ of one per cent from Jupiter's secular perihelion, or locus of incipient nebular rupture. The mass of Neptune is approximately $\frac{51}{3}$ of Earth's harmonic mass. Uranus is almost precisely $\frac{5}{13}$ of the Uranus-Neptune belt. Saturn is almost precisely $\frac{3}{13}$ of the Jupiter-Saturn belt. The numbers $\frac{1}{3}$, $2 \times \frac{5}{13}$, $\frac{5}{13}$ and $\frac{3}{13}$ are all phyllotactic. The values which fully satisfy these mass relations are

Sun ÷ Neptune	19352.76
Sun ÷ Uranus	22579.32
Sun ÷ Saturn	3490.71
Sun ÷ Jupiter	1047.21

440. *Linkage of Earth and Neptune.*

It was shown in Note 428 that Earth's mass may be harmonically deduced from Sun's mass through its limiting value of circular orbital velocity. Neptune's mass may be deduced from Earth's through the corresponding limit of orbital time. We have, accordingly, $m_8 : m_3 :: t_a : t_\beta ::$ 16.98 : 1. In this proportion $t_a = 2\pi \sqrt{\frac{r}{g}}$; t_β = a sidereal day.

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In notes 425 and 426, the gravitating accelerations of Earth and Jupiter were shown to be harmonically related to each other, as well as to the gravitating acceleration of the Sun. The moon furnishes another harmonic link, which is shown by the equation

$$60.2778 \times 5.202798 \times 1047.879 = 328629.$$

In this equation 60.2778 is von Littrow's estimate of Moon's mean distance in equatorial semidiameters of the Earth; 5.202798 is Jupiter's mean distance, in Earth's mean vector radii; 1047.879 is the quotient of Sun's mass by Jupiter's mass; 328629 is, within less than $\frac{1}{8}$ of one per cent, the harmonic quotient of Sun's mass by Earth's mass.

444. *The Meteoric Theory of World Building.*

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of influences which may be regarded as meteoric. Indeed, Herschel's subsidence-theory recognizes the continual activity of such influences, provided we consider every particle which is falling towards the sun as meteoric. If we still further regard the luminiferous æther as material, we may consider ourselves as living in a condensing and rotating nebula.

445. *Linkage of Sun, Earth, Jupiter and Saturn.*

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Substituting in this equation the harmonic ratio of Sun to Eårth (329196) and Bessel's estimate of Sun $\div$ Saturn (3501.6), we get for Sun $\div$ Jupiter 1048.5.

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The centre of a nebula which is bounded at opposite extremities of its diameter by the secular aphelia, or loci of incipient subsidence, of Neptune and Uranus, according to Stockwell's estimate, is 4.8952. This differs by less than $\frac{1}{5}$ of one per cent from Jupiter's secular perihelion, or locus of incipient nebular rupture. The mass of Neptune is approximately $\frac{3}{2}$ of Earth's harmonic mass. Uranus is almost precisely $\frac{5}{13}$ of the Uranus-Neptune belt. Saturn is almost precisely $\frac{3}{13}$ of the Jupiter-Saturn belt. The numbers $\frac{1}{2}$, $2 \times \frac{3}{13}$, $\frac{2}{34}$ and $\frac{3}{13}$ are all phyllotactic. The values which fully satisfy these mass relations are

Sun $\div$ Neptune	19352.76
Sun $\div$ Uranus	22578.22
Sun $\div$ Saturn	3490.71
Sun $\div$ Jupiter.	1047.21

453. *Mass of Saturn.*

Dr. Meyer's estimate of $m_o \div m_8$ (*The Observatory*, vi, 279), is 3482.9 ± 5 5. This is nearly identical with Hall's value, as given in Note 436. Meyer includes the rings, estimating their mass as equivalent to $\frac{1}{119.1} m_8$. Bessel's estimate was $\frac{1}{118}$. If we omit the rings, $m_o \div m_8$ becomes, according to Meyer, 3512.2, which is substantially identical with Leverrier's value (3512). Substituting in Alexander's harmony we get, for Saturn's mean distance, 9.52513_{ρ_3}, which differs by less than ¼ of one per cent from the generally accepted distance.

	3512.2	3.5455792	30
(26) + ½ (30 — 23)	9.52513	9788709	31

454. *Orbital Momentum.*

The logarithms which represent orbital momentum for Earth and Venus (Note 437) are as follows:

		.7233323	$\bar{1}$ 8593379	32
½ (32)		.85049	$\bar{1}$ 9296690	33
(11 — 33)	387066		5.5877854	34

Notes 451-4 give simple harmonic approximations to all the masses of the eight primary planets. I think this is the first publication in which a uniform scale has been adopted for all the planets, and I submit it fearlessly for comparison with any estimate which has been based on ordinary astronomical data

455. *Linkage of Earth and Jupiter.*

We are now prepared for a systematic examination of the linkages among the different belts. In note 425 we found that the gravitating energies, at the chief centres of nucleation and of nebulosity, are so connected as to give the equation:

$$(1 - e)\, g_5\, t_5 = \sqrt{g_0\, r_0}.$$

The value of $\sqrt{g_0\, r_0}$ may be found by the following logarithms:

2π		.7981799	35
½ (27)		3.4969032	36
31558149		7.4991115	37
(35) + (36) — (37)		$\bar{4}$ 7960616	38
2 (38)		$\bar{7}$ 5921232	39
t_5 =	17863 25	4.2519605	40
(38) — (24) — (40)		$\bar{8}$.5713557	41
(41) — (39)		$\bar{2}$ 9792325	42
½ (— 23 — 42)		$\bar{1}$.0002283	43

456. *Earth's Mean Radius Vector.*

The mean radius vector of the chief centre of condensation is harmonically found by the methods of Notes 428 and 434.

$g_3 = .00607723$ miles.	$\bar{3}.7837055$	44
$r_3 = 3962.8$	3.5980022	45
$\sqrt{g_3 r_3} = 4.90743$	.6908538	46
$\frac{3}{2} \times \frac{5}{2}$	.5740313	47
(46) + (47)	1.2648851	48
(48) + (37) — (35)	7.9658167	49
.99879	$\bar{1}.9994742$	50
(49) — (50)	7.9663425	51

The value of $m_0 \div m_3$, which represents this mean distance, may be found by the formula:

$$4 \left(\frac{\rho_3}{r_3}\right)^3 \pi^2 r_3 \div (g_3 \times 31558149^2) = m_0 \div m_3$$

$$3\,(51 - 45) + 2\,(35) + (45) - (44) - 2\,(37) = (11)$$

457. *Second Linkage of Earth and Jupiter.*

The linkage between the superficial gravitating energies of Earth and Jupiter, which is shown in Note 426, may be computed as follows:

$\frac{1}{3}$ (24 + 42 + 43)	$\bar{2}.9761030$	52
(38 + 52)	$\bar{5}.7721646$	53
(26 + 46 — 53)	5.6349261	54
(27 + 54)	7.9662549	55
(38 + 54)	2.4309877	56
2 (56 — 46) + (54 — 45)	5.5171917	57
(43 + 54 — 45)	1.0371521	58

458. *Other Terrestrial Linkages.*

The linkage of Earth, Moon and Jupiter, which is represented in Note 443, introduces the following logarithms.

60.2778	1.7801574	59
(59 + 26 + 23)	5.5167054	60

The linkage of Earth and Neptune (Note 440) with Earth's oblateness gives the following logarithms:

$\frac{1}{2}$ (45 — 44)		2.9071484	61
(61 + 35)		3.7053283	62
86164.08		4.9353263	63
(63 — 62)	16.9824	1.2299980	64
(11 — 64)	19384.58	4.2874564	65
2 (64)	288.4	2.4599960	66

The linkage of Earth and Uranus, Note 443, gives the following logarithms :

365 2565		2 5625979	67
338,2183		2.5291971	68
(67 — 68)	1.07904	.0334008	69

459. *Moon's Mass and Earth's Eccentricity.*

The harmonies of lunar mass and Earth's orbital eccentricity (Notes 431–3) introduce the following logarithms :

π		.4971499	70
7989		3 9024924	71
20000000		7.3010300	73
(70 + 71 — 72)	.0012549	$\bar{3}$ 0986123	73
— (73)		2 9013877	74
(74) — 2 (70)	80.74	1.9070879	75
48082 04 $\cdot t_n$		4 6342963	76
(44) + 2 (76) — 2 (70)		6.0579984	77
(55 — 77)	80.957	1.9082566	78
81.957		1.9135861	79
(44 + 76)		2.4180018	80
2 (80) + (78) — 2 (56) — (79)		$\bar{1}$ 9686987	81

460. *Series of Harmonic Equations.*

The harmonic analogy between the Neptune-Uranus and the Mars-Mercury belts may be still further extended by the following equations, which enable us to deduce all the masses of the primary planets from the harmonic value of the mass at the chief centre of condensation :

$$g = \frac{v_\lambda m}{t r^2} \qquad \alpha$$

$$\tfrac{3}{4} \times \tfrac{5}{2} \times \sqrt{g_s r_3} = \sqrt{\gamma_3 \rho_3} \qquad \beta$$

$$t_\alpha \div t_\beta = m_8 \div m_3 \qquad \gamma$$

$$\pi^2 (1 + e_3) (m_6 + m_7) = m_5 \qquad \delta$$

$$\pi^2 (m_1 + m_4) = m_2 + m_3 \qquad \varepsilon$$

$$\rho_8{}' \div \rho_7 = m_8{}^2 \div m_7{}^3 \qquad \zeta$$

$$m_0\, m_5\, m_9 = m_5{}^3 \qquad \eta$$

$$\rho_1 \div \rho_4 = m_1{}^3 \div m_4{}^2 \qquad \theta$$

$$\rho_2 \div \rho_3 = m_2{}^3 \div m_3{}^2 \qquad \iota$$

461 *Explanation.*

In the foregoing note g = gravitating acceleration of any mass m, at any distance r, provided m and r are expressed in units of Sun's mass and semi-diameter ; v_λ = velocity of light ; t = time of solar half-rotation ; γ_3 = solar gravitating acceleration at Earth's mean radius vector (ρ_3) ; t_α = time of theoretical satellite rotation at Earth's equatorial surface =

$2\pi\sqrt{\frac{r_1}{g_1}}$; t_a = a sidereal day; e_8 = Neptune's minimum secular eccentricity; ρ_8' = Neptune's mean secular aphelion; ρ_1 to ρ_8 = mean vector radii and m_1 to m_8 = masses of the eight primary planets.

The equations represent various obvious radial and tangential actions and reactions. Equation (1), when applied at the Sun's surface, which is the point of greatest gravitating acceleration in the solar system, gives $g\,t = v_\lambda$. This satisfies Ohm's law, as applied to solar rotation in a magnetic field, Fourier's theorem, Laplace's principle of periodicity, and the projectile velocity which balances æthereal resistance at Sun's surface. The actions and reactions of centripetal gravitation and centrifugal radiation are thus coördinated in such ways as to give simple forms of expression for all kinetic correlations. Equations (4) and (5) represent similar tangential tendencies to belt formation by the *vis viva* of primitive tangential motion, both at the outer limits of the solar system and at the outer limits of the belt of greatest condensation. Equation (2) represents a harmonic relation of tangential velocities, at the chief nucleal centre and at the chief centre of condensation. This equation satisfies Laplace's demonstration of the tendency to exactness in simple numerical relations. It also satisfies various tendencies of subsidence as well as of linear and of rotary inertia. Equation (9) gives harmonic tangential velocities to the two interior companion masses, in the belt of greatest condensation. Equations (6), (7) and (8) represent radial and belt-rupturing tendencies of simple subsidence. In the mutual interactions of gravitating subsidence the sums of the gravitating accelerations, along mutually connecting lines, vary as the respective masses; therefore $\frac{mg^2}{2}$, or the *vis viva* of subsidence, varies as m^3. Equation (3) represents harmonic interactions between the centre of primitive subsidence (m_8) and the chief centre of condensation (m_4). The importance of these interactions is still further exemplified by the fact that $(t_\beta + t_a)^2$ = Earth's oblateness according to Listing's estimate (Note 440). This accordance seems calculated to throw great doubt upon Delaunay's hypothesis of retardation by the "tidal brake."

462. *Deduced Values.*

The following harmonic values satisfy the equations of Note 460. Some of the latest astronomic estimates are also given, in order to show the closeness of accordance:

	Harmonic.	Astronomical.	
$m_0 + m_1$	4527977	4512885	Encke.
$m_0 + m_2$	387066	396256	Hill.
$m_0 + m_3$	329196	329161	Faye.
$m_0 + m_4$	2867780	2869157	Hall.
$m_0 + m_5$	1049.4	1050	Leverrier.

	Harmonic.	Astronomical.	
$m_0 \div m_6$	3510.7	3512	Leverrier.
$m_0 \div m_7$	22508.7	22600 ± 100	Newcomb.
$m_0 \div m_8$	19384.6	19380 ± 70	Newcomb.

463. *Evidence of Nebular Subsidence.*

The outer portion of the Neptune-Uranus belt is harmonically connected with the belt of greatest condensation, as we have seen (Note 440), by an important mass-relation. One linkage of the inner portion of the same belt was given in Note 442; another is found in the proportion

$$t_a : t_\beta :: (\rho_3 + \tfrac{1}{2}\rho_0)^3 : \rho_7^3.$$
$$1 : 366.2565 :: (1.00233155)^3 : (19.18244)^3$$

Leverrier's estimate of ρ_7 is 19.18264, which differs from the harmonic estimate by less than $\frac{1}{4}$ of Sun's semi-diameter. This harmony introduces: (1) The rupturing tendencies of nebular subsidence through $\frac{1}{2}r$; (2) The interstellar parabolic influences which have determined the harmonic positions of the eight primary planets and of the asteroidal belt (Note 46); (3) The conversion of parabolic into elliptical influence, with foci at the centres of Earth and Sun; (4) The variation of the times of nebular rotation inversely as the square of radius. These relations, taken in connection with equation δ, Note 460, furnish conclusive evidence in support of Herschel's "subsidence theory."

464. *Earth's Dependence on Luminous Undulation.*

The influence of luminous undulation in determining Earth's orbital period is quite as remarkable as its influence upon the time of solar rotation. The latter represents the maximum energy, while terrestrial revolution represents the mean energy of luminous undulation. In accordance with the general principle that, when a disturbance consists of terms involving sines or cosines of angles which vary with the time, the maximum energy is twice the mean energy. According to Stockwell, the secular centre of the belt of greatest condensation is at 1.0169394$_{\rho_3}$, which is an arithmetical mean between Earth's mean radius vector and its mean aphelion. Earth, like Jupiter, shows the energy of ætherea] projection as well as the mean energy of luminous undulation. We find, accordingly, $g_3 \times 1$ year $= 1.0338788 v_\lambda$. This gives $v_\lambda = 185501.5$ miles.

465. *Jupiter's Dependence on Luminous Undulation.*

The combined influence of luminous undulation and central condensation, in determining Jupiter's orbital velocity, is equally striking.

$$1.0169394 r_3 : \rho_5 :: \sqrt{\gamma_5 \rho_5} : v_\lambda$$

Substituting the harmonic value of ρ_3 (92542800), this proportion gives $v_\lambda = 185498.1$ miles.

466. *Neptune's Dependence on Luminous Undulation.*

The varied harmonies which have been pointed out between the Neptune-Uranus belt and the dense belt, may naturally lead us to seek for some additional evidence of luminous influence at the outer limit of the solar system. Such evidence is furnished by the proportion :

$$\rho_a : \rho_\beta :: \rho_\gamma : \rho_3.$$

In this proportion ρ_a = Neptune's secular aphelion + Earth's mean aphelion ; ρ_β = Neptune's secular aphelion ; ρ_γ = centre of belt of greatest condensation. Substituting Stockwell's apsidal elements and the harmonic value of ρ_3, the proportion gives $v_\lambda = 185492$ miles. The extreme range of discrepancy in the three estimates (Notes 464–6) is less than $\frac{1}{121}$ of one per cent, or less than ten miles per second.

467. *Harmonic Estimate of the Constant of Aberration.*

Earth's mean orbital velocity is $1296000'' \div 31558149 = 0''.041067$; $v_\lambda = 185497.2$ miles, if we take the mean of the three foregoing estimates. To find the constant of aberration we have the proportion :

$$185497.2 : 92542800 :: 1 \text{ sec.} : 498.89 \text{ sec.}$$

$$0''.041067 \times 498.89 = 20''.488.$$

The close accordance of this value with Nyrén's estimate (Note 449), furnishes satisfactory confirmation both of the accuracy of Stockwell's calculations and of the precision of the harmonic estimate.

468. "*V.*"

The foregoing results abundantly show that the principle of harmonic motion is of "immense use not only in ordinary kinetics, but in the theories of sound, light, heat, etc." * Analogy, the law of parsimony, the theories of kinetic correlation, and the various principles enumerated in Note 461, all point to the value of v_λ, which is given in the foregoing note, as equivalent to the ratio "*V*" between the electrostatic and electromagnetic units of electricity, electric current, magnetic potential, electric displacement, surface density, magnetic force, and strength of current at a point. The corresponding resistance in the field of rotation is 29.853 Ohm's. This agrees very closely with Foucault's estimate, 29.836 Ohm's. Weber's estimate † was 31.074 ; Thomson's ‡ 28.2 ; Maxwell's ‡ 28.8 ; Michelson's § 29.982. The modulus of light which is represented by the harmonic constant of aberration may be found as follows : $r_0 = \rho_3 \div 214.4513 = 431582.8$ miles ; $g_0 = m_0 r_3^2 \div m_3 r_0^2 = .16878$ miles ; $\pi r_0 \div v_\lambda = 7.3085$ sec. ; $7.3085 g_0 = 1.233$ miles = v of solar rotation ; $\sqrt{g_0 r_0} = 269.82$ miles ; $269.82 \div 1.233 = 218.833$; $(218.833\pi)^2 r_0 = 472633 r_0$ = modu-

* Thomson and Tait, *Nat. Phil.*, i, Sec. 52.

† *Pogg. Ann.*, Aug. 10, 1856.

‡ Rept. Brit. Assoc., 1809, pp. 434, 436.

§ *Am. J. Sci.*, Nov., 1879.

lus of light at Sun's surface; Laplace's limit, $L = 218.833^{\frac{2}{3}} r_0 = 36.314 r_0$. An additional linkage of Sun, Earth, Jupiter and Neptune is shown by the proportion:

$$L : \rho_5 :: \rho_{3.3} : \rho_{8.3}.$$

In this proportion $\rho_{3.3}$, $\rho_{8.3}$ represent secular perihelion of Earth and Neptune, respectively. Substituting Stockwell's value of $\rho_{3.3}$ gives $\rho_{8.3} = 29.68 \rho_3$. Stockwell's estimate is $29.78 \rho_3$.

469. *Another Linkage of Jupiter and Earth.*

Let v_a = *vis viva* of circular orbital revolution which Jupiter, when at mean aphelion, would be able to give to a particle at the centre of the solar system $= m_5^2 \div \rho_a$; v_3 = molecular *vis viva* which Earth would be able to communicate to the same particle $= \frac{2}{5} (m_3^2 \div \rho_3)$; v_λ = velocity of light; v_3 = circular orbital velocity of a particle at the chief centre of condensation in the solar system (Earth). Then we find $v_a : v_3 :: v_\lambda : v_3$. Substituting the harmonic values of Earth's mass and of the constant of aberration, with Stockwell's estimate $\rho_a \div \rho_3 = 5.427351$, we find $v_\lambda \div v_3 = 10067.61$; $m_5 \div m_3 = 318.61$; $m_0 \div m_5 = 1049.69$, which differs by less than $\frac{1}{38}$ of one per cent from the value which was deduced in Note 462. This relation shows that, when nebular subsidence and luminous undulation had established incipient orbital motion around the Sun at Jupiter's mean aphelion, the actions and reactions among nucleal centres established the molecular motion, at the chief centre of density, which resulted in Earth's orbital oscillation. The first indication of the importance of the factor $\frac{2}{5}$ appears to have been given by me (Proc. Amer. Phil. Soc. xii, 394). Maxwell subsequently adopted it (P. Mag., June and Sept., 1877, pp. 453, 209) without leaving any record of the source from which he derived it, or of the reasons upon which it was based. In all of my investigations my first inquiry is, what obvious radial or tangential velocity, momentum, or *vis viva* is there, which would be likely to operate in producing or maintaining such exactness of cyclical harmony as is necessary for the stability of the system. The first trial usually gives some clue which suggests the next. These alternations, between Baconian observation and the "scientific use of the imagination," have been rewarded by frequent confirmations of predictions which I had hazarded and recorded weeks, months, or years, before they could be sustained by any known data.

470. *Dense-Belt Projection.*

The interstellar parabolic trajectories, which have tangential directices at Sun's surface, and a common focus at Sun's centre, have a vertical locus at $\frac{r_0}{2}$. The length of the luminous undulation which becomes semi-circular in solar rotation is πr_0. The sum of these two centrifugal

tendencies is $3.641593r_0$, or $.0169414\left(\rho_1+\frac{\rho_0}{2}\right)$, which differs by less than $\frac{1}{14}$ of one per cent from Stockwell's estimate of the projection of the centre of the dense belt. For the influence of $\rho_1+\frac{\rho_0}{2}$ upon the orbital locus of Uranus, see Note 463.

471. *Sun's Equatorial Acceleration.*

The luminous projection of Jupiter and of the centre of the dense belt, as well as the other evidences of apsidal influence upon planetary harmonies, show that molecular *vis viva* has slightly modified the simple undulatory *vis viva* of the luminiferous æther. The amount of the solar equatorial acceleration is not precisely known, because no Sun-spots have been observed very near the solar equator; it cannot, however, differ much from Earth's mean secular eccentricity. We may, therefore, regard this as another evidence of the harmonic importance of "subsidence" to the belt of greatest density.

Stated Meeting, June 20, 1884.

Present, 5 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was read from James H. Hutchinson, M.D., dated May 16, 1884, No. 133 South Twenty-second street, Philadelphia.

The decease of Prof. Dr. Heinrich Robert Göppert, at Breslau, May 18, 1884, aged 83, was announced.

A letter was received from J. M. Da Costa, M.D., accepting the appointment to prepare an obituary notice of the late Dr. Gross.

Prof. Baird requested, by letter, a copy of Proceedings No. 110 for the Library of the Imperial Museum at Strasburg, which was ordered to be sent.

Prof. E. D. Cope requested, by letter, the insertion of a paragraph in the Proceedings enlarging the notice of the minutes of January 18, 1884.

An application was read for the Magellanic Premium, signed "*Arcturus*," on the explosion of tanks containing petroleum, and the method of preventing the same.

Prof. Cope sent a paper on the Extinct Mammalia of Valley of Mexico.

Mr. Richard Vaux read a paper on the history of the Pennsylvania prison system.

Nominations Nos. 1023 to 1028, were read.

Letters of acknowledgment were received from the Holland Society at Harlem (114); the Fondation Tyler (114); the Royal Zoölogical Society, Amsterdam (113, XVI, i); the Observatory at Prague (113, XVI, i); the Royal Society of Sciences, Göttingen (XIII, i, ii); the Radcliffe Observatory (114); the Royal Observatory, Edinburgh (113, XVI, i); Wm. Blades, 23 Abchurch Lane, London (114); the Statistical Society, London (114).

Letters of Envoy were read from the United States Consul at Budapest, April 29, 1884, the Royal Zoölogical Society, Amsterdam, June 4; the Musée Guimet, April 16, and the National Academy at Cordova, South America, requesting exchanges.

Donations for the Library were received from the Geological Survey of India; Academy at St. Petersburg; Mr. Joseph de Lenhossek, of Budapest; Anthropological Society, Geological Institute, Vienna; Royal Bavarian Academy; Royal Saxon Society; Royal Society, Göttingen; Royal Prussian Academy; Society at St. Gall, National Antiquarian Society, Copenhagen; Tuscan Society of Natural Sciences, at Pisa; Musée Guimet and Society Agriculture, Lyons; Commercial Geographical Society and Meteorological Commission, Bordeaux; Institute of France, Ethnological Society, Anthropological Society, Zoölogical Society, Geographical Society, M. Leon de Rosney, Society of Americanists, Society for Japanese Studies, Bureau of Longitudes, M. M. Locroy, Paris; Royal Academy of History at Madrid; Astronomical Society, Geographical Society, Nature, London; Cambridge University; Glasgow Observatory; Pat-

rick Geddes, of Edinburgh; Nova Scotia Institute of Sciences; Boston Society Natural History; American Journal Science; American Chemical Society; New York Historical Society, New York Academy of Sciences, New York Meteorological Observatory, Philadelphia Academy Natural Sciences, Franklin Institute, Journal of Pharmacy, Engineers' Club, Zoölogical Society, Dr. Geo. L. Harrison, J. A. Kirkpatrick, Heber S. Thompson, Edwin Atlee Barber, Henry Phillips, Jr., E. D. Cope, A. E. Foote, Eli K. Price, American Journal of Philology, Baltimore Johns Hopkins University, United States National Museum, United States Army Bureau of Engineers, Census Bureau, Jed. Hotchkiss, of Staunton, Virginia, American Antiquarian, Chicago.

And the meeting was adjourned.

Stated Meeting, July 18, 1884.

Present, 3 members.

President, Mr. FRALEY, in the Chair.

A letter was received from the President of the Committee for erecting a statue to Jean Baptiste Dumas, and requesting a subscription for the same.

The death of Dr. Karl Richard Lepsius was announced as having taken place July 11, 1884, ætat. 83.

A letter was received from Gen. W. F. Reynolds announcing a change of address to Detroit, Michigan.

Letters of acknowledgment were received from the Royal Academy of Sciences, Amsterdam (113, XVI, i); Royal Institute, Lombardy; Prof. J. S. Steenstrup (113); K. K. Central Institute (114); University Library, Cambridge (114); New Hampshire Historical Society, Concord (115); American Antiquarian Society, Worcester (115); Essex Institute (115); Boston Athenæum (115); American Statistical Asso-

ciation, Boston (115); Connecticut Historical Society (115); W. P. Blake, New Haven (115); W. D. Whitney, New Haven (115); New York Historical Society (115); Library United States Military Academy, West Point (115); C. H. F. Peters, Clinton, New York (115); New Jersey Historical Society (115); Numismatic and Antiquarian Society (115); Wyoming Historical and Geological Society, Wilkes-Barre (115); Pennsylvania State Library (115); Thos. C. Porter, Easton, Pennsylvania (115); Leander McCormick Observatory, Virginia (115); Georgia Historical Society (115); Cincinnati Observatory (115); Robert Peter, Lexington (115); Library of the University of Tennessee (115); Henry S. Frieze, Ann Arbor (114, 115); State Historical Society of Wisconsin (115); Kansas State Historical Society (115); Geological Survey, Washington, a set of the publications of the American Philosophical Society.

Letters of envoy were received from the Society of Natural Sciences of Elberfeld, and the Royal Society of Canada.

Donations to the Library were received from the New Zealand Institute; Royal Friedlander, Berlin; K. K. Observatory in Prag; Societies of Natural Sciences at Emden, Elberfeld and Lausanne; Central Bureau of Statistics, Stockholm; Royal Academy of Belgium; Royal Observatory at Bruxelles; M. Paul Albrecht; Ecole des Mines; Societies of Geography at Paris and Bordeaux; M. B. Balliere & Son; M. Paul Tournafond; Society of Physical and Natural Sciences at Bordeaux; Prof. C. H. F. Peters; Prof. Luigi Ambiveri; Society of Antiquaries; Royal Astronomical Society; Journal of Forestry; Nature; Essex Institute; M. Franklin B. Hough; American Academy of Arts and Sciences; American Oriental Society; the Boston Society of Natural History; S. E. Cassino & Co.; the Peabody Museum; Harvard University; the Free Public Library of New Bedford; American Journal of Science; Yale College; American Chemical Society; Mercantile Library; New York Meteorological Observatory; American Journal of Medical Sciences; College of Pharmacy; McCalla & Stavely; the Franklin Institute; Prof.

E. D. Cope; Dr. D. Jayne; Mr. Henry Phillips, Jr.; the Wyoming Historical and Geological Society; Johns Hopkins University; Peabody Institute; United States Geographical and Geological Survey; Department of the Interior; Mr. Jed. Hotchkiss; Geological Survey of Kentucky, and the National Academy of Sciences in Cordova (Argentine Republic).

Permission was granted to Mr. Henry Phillips, Jr., to have copies made of Schultze's Arawak grammar and dictionary (MSS. owned by the Society), for the use of Mr. E. F. im Thurn, of Demerara, British Guiana.

The Special Committee, appointed May 16 to have the paintings owned by the Society cleaned and put in good order, was ordered to ascertain the cost of photographing the same.

The following new members were elected:

Sir John Lubbock, LL.D., Westminster, London.
E. Burnett Tylor, LL.D., Museum House, Oxford.
Wm. W. Keen, M.D., Philadelphia.
N. Archer Randolph, M.D., Philadelphia.
Rev. E. W. Syle, D.D., Philadelphia.
Rev. H. Clay Trumbull, D.D., Philadelphia.

New nominations, Nos. 1029, 1030, were read, and the meeting was adjourned.

Correction of Minutes of January 18.

Professor Cope remarked that the formation which forms the banks of the Rio Grande at Laredo, Texas, is in all probability the Laramie. It contains at that point a thick bed of pure lignite. Above Laredo, on both sides of the river, an excellent lignite is mined. The wide valley of the Rio Grande as far as the eastern ranges of the Sierra Madre is probably of Laramie age, as Dr. C. A. White reports fossil mollusca of that age from near Lampazas, at the foot of the mountains. Wm. Arthur Schott (U. S. Mex. Bound. Survey I, Geology, p. 35) first observed these lignites, and Mr. Conrad pointed out the existence of Claiborne Eocene beds in the same region (loc. cit., p. 141). Professor Cope stated that the Claiborne beds rested immediately on the Laramie at Laredo.

Notes upon the Codex Ramirez, with a translation of the same. *By Henry Phillips, Jr.*

(Read before the American Philosophical Society, October 19, 1883.)

Perhaps one of the most valuable fragments of antiquity that has survived the bigoted fury of the Spanish ecclesiastics is the Codex Ramirez, a history of the Mexicans as shown forth by their hieroglyphical and symbolical writings. It was prepared shortly after the Conquest by the orders and for the use of Señor Ramirez de Fuen Leal, Bishop of Cuenca, President of the Chancelleria, to be used in deciding upon questions of all nature that were likely to arise before that tribunal. He caused the Aztec sages and priests to come together before him, and to agree upon an explanation of the characters and signs in which the law, history and mythology of the Mexicans were written. As an authentic exposition of such, it is unique and of the greatest value to students.

Brinton (Am. Hero Myths, 78), calls it "the most valuable authority we possess;" Pinelo (Vol. II, 603), refers to its having been used by Herrera; Chavero (Anales del Museo Nacional, III, iv, 120), "*se considera como la mejor fuente, acaso la unica verdaderamente autorizada, para conocer los hechos pasados en Tenochtitlan.*" When Bishop Ramirez returned to Spain, he took with him this MS., which now exists in Madrid in a volume of twelve leaves folio entitled *Libro de oro y Thesoros Indicos*, and bears upon it various memoranda attesting its authenticity.

The work is extremely difficult to understand, and full of obscurities arising partly from errors in transcription, partly from the use of antiquated expressions, and a most involved and puerile style, and partly from incorrect and vulgar orthographies.

In the following translation I have endeavored to reproduce the simplicity and meaning of the original, adding copious notes of explanation and conjecture wherever a passage seemed to demand it.

(NOTE.—*Tz* is pronounced like the Maya *Ç*; *X* like the sound of *sh* in English; *l* between two "l"'s is dropped; *o* and *u* were pronounced almost identical (*Molina*). Anales de Museo Nacional, I, VI, 242.)

HISTORY OF THE MEXICANS AS TOLD BY THEIR PAINTINGS.

CHAPTER 1ST.

Of the Creation and Beginning of the World and of the Original and Superior Deities.

Through symbols and writings formerly used, through the traditions of the old and of those who in the days of their infidelity were priests and pontiffs, and through the narrations of the lords and chief men to whom they were accustomed to teach the law and educate in their temples in order to render them learned, brought together before me with their books and hieroglyphics, which according to what is demonstrated are believed

This Map of the Environs of the City of Mexico is reproduced from *Le Petit Atlas Maritime* * * * par Le Sieur Bellin, par ordre de M. Le Duc de Choiseul. Paris 1764. Vol. 2, Pl. 5. The configuration of the Lakes of Mexico and Chalco, however, is incorrectly represented.

to be of ancient origin, many of them anointed with human blood, it appears that there was originally one god named *Tonacatecli*,[1] who took for wife *Tonacaçiguatl*, or as she is sometimes called *Cachequacalt*, who created themselves, and were perpetual inhabitants of the thirteenth heaven; of whose creation and beginning likewise there is nothing known except the fact that it also originated in the thirteenth heaven. Of this god and goddess were engendered four sons, the eldest was called *Tlaclau quetezteatlipuca*,[2] whom the peoples of Quaxoçingo and Tascala reverenced as their chief divinity under the name of *Camaxtle*,[3] and who was said to have been born of a ruddy color all over. They had a second son named *Yayanque tezcatlipuca;* he who was the greatest and the worst, who overpowered and bore sway over the other three, because he was born in the middle of all (*naçio en medio de todos*); he was totally black at birth. The third was called *Queçalcoatl*,[4] and for another name *Yaguelicatl*. To the fourth and the smallest they gave the appellation of *Omitecilt*,[5] and *Maquezcoatl*, whom the Mexicans termed *Vchilobi*, because he was left-handed, and looked upon him as their chief deity, because in the land from whence they came, he was so considered, and was more especially the god of warfare than were the other divinities. Of these four sons of *Tonacatecli* and *Tonacaçigulatl* (*sic*), *Tezcatlipuca* was the one who knew all thoughts, and was in all places and read all hearts, for which he was called *Moyocoya*,[6] which is to say "the all-powerful," according to which idea he is represented in painting only as the air, by which name he is not commonly known. *Vchilobi*,[7] the younger brother, and god of the Mexicans, was born without flesh (*naciò sin carne*), but only bones, in which condition he lived six hundred years, during which period of time the gods did nothing whatever, the father as well as the sons, and in their representation there is no account taken of these six hundred years, counting them as they do from twenty to twenty, according to the sign which he holds, which stands for twenty. These gods were known by these and many other names, according to how their attributes are understood, for each community called them differently by reason of their dialects, and so they were given diverse appellations.

CHAPTER 2D.

Of how the World was created and by whom.

When the six hundred years after the birth of the four brethren-gods, the sons of *Tonacatecli*, had passed away, they all four came together, and said that it was good that they should arrange what they had to do, and the law they were to be governed by, and they all committed to *Quezalcoatl* and *Vchilobi*, the performance of this task, in pursuance of which they created, under the orders and judgment of the others, the fire, and this being done they made the half-sun, which, on account of not being entire, gave not much but only a slender light. Presently they created a man and a woman; the man they called *Vxumuco*, and the woman *Çipastonal*,[8] and to them they gave command that they should till the ground, and that the woman

should spin and weave, and that of them should be born the *Maçeguales*, and that they should find no pleasure, but should always be obliged to work; to the woman the gods gave certain grains of *maiz*,[9] so that with them she should work cures, and should use divination and witchcraft, and so it is the custom of women to do to this very day. Then they created the days which they divided into months, giving to each month twenty days, of which they had eighteen, and three hundred and sixty days in the year, of which will be spoken subsequently. Then they created *Mitlitlatteclet* and *Michitecaçiglat*, husband and wife, and these were the gods of the lower regions (*infierno*), in which they were placed; then the gods created the heavens below the thirteenth, and then they made the water and created in it a great fish similar to an alligator which they named *Çipaqli*, and from this fish they made the earth as shall be told; and to create the god and goddess of water, all the four divinities joined themselves together, and made *Tlalocatecli*,[10] and his wife *Chalchiutlique*,[11] whom they assigned to be the gods of water, to whom they betook themselves in prayer whenever it was needful. Of this god of water it was said that he had his dwelling of four apartments, in the middle of which was a large courtyard, where stood four large earthen pans full of water. In one of these pans the water was excellent, and from it the rain fell which nourished all manner of corn and seeds and grain, and which ripened things in good season; from the second rained bad water from which fell cobwebs on the crops, and blight and mildew ensued; from another fell ice and sleet; when from the fourth rain fell nothing matured or dried. This god of rain water created many servants, small of body, who were in the rooms of the aforesaid house, and they held money boxes,[12] in which they caught the water from the great earthen pans, and various rods in the other hand; and when the god of water sent them to irrigate any especial places, they started off with their boxes and sticks, and let fall the water where they were directed, and when it thunders the noise is caused by their striking the boxes with their rods, and when it lightens it comes from within these boxes. It is eighty years since Señor de Chalco wished to sacrifice to these servants of the gods of water one of his hunchbacks [13] and took him to the Volcano, a very high mountain always covered with snow, fifteen leagues distant from the City of Mexico, and placed the humpback inside of a cave of which the entrance was closed up, and from lack of food he became drowsy, and was carried to where he could see the aforesaid palace and the manner of life of the deity; sometime later the servants of Señor de Chalco came to look for him to see if he were dead, but finding him living, took him home where he told what he had seen; in this very year the people of Chalco were subdued by the Mexicans, and became enslaved, and it was said that this had been the signal for their loss as it took place. Afterwards all the four gods, being united in work, they created from the fish *Cipacuatli*[14] the earth, which they called *Tlaltecli*,[15] and represent as the god of the earth, extended over a fish as having been made of it.

Chapter 3d.

Of the Creation of the Sun, and how many Suns there have been, and how long each one lasted, and how the Macegauales ate in the time of each Sun, and of the Giants in those Days.

All the aforesaid was made, and created without any account being taken of the year, except that it was all in one, and without any difference of time, and it is narrated that of the first man and woman who did as has been already said, about the time when these things began to be performed, there was born a son to whom was given the name of *Pilcetecli*, and as there was lacking some woman for him to marry, the gods made of the hairs of *Suchiqueçar*,[16] a woman with whom his first marriage took place. When this was done all the four deities took notice that the half sun which they had created gave but very little light, so they resolved to make another half sun, so that it should illumine the whole earth. When *Tescatlipuca* saw this he became himself a sun in order to give light, as we represent him in painting, and they say that what we see is only the brightness of the sun and not the sun himself, because the sun rises in the morning, traverses till midday, and then returns to the east in order to start again next day, and that which is visible from noon till sunset is its brightness, and not the sun itself, and that at night it neither shows itself nor has motion. So from being a god *Tezcatlipuca* made himself a sun, and then all the other deities created giants, who were very large men, and of such extreme strength that they could tear up trees with their hands, and they lived on the acorns of evergreen oak trees, and nothing else.[17] This state of affairs lasted as long as this sun did, which was thirteen times fifty-two years, which make 676 years.

Chapter 4th.

Of the manner which they have of reckoning.[18]

And since they commence to count time from this first sun, and their reckoning runs on from it continuously, leaving behind the 600 years, the period of the birth of the gods, and while *Vchilobus* was in his bones, and without flesh, as has been narrated, I shall now proceed to tell the manner and order in which they reckon their year, and this is it. As has been already said, each year contains 360 days, and 18 months, each month of 20 days; and of how they use up 5 days in festivals, which became fixed, we shall speak later in our chapters touching on the feasts and their celebrations. Holding the year as has been said they correct from four to four, and neither in their language nor in their paintings, take any account of more than four years. The first they call *tectapatl*, and paint it as a stone or flint with which they cut open the body in order to draw out the heart; the second, *calı*, which they represent as a house, for by this name they call a house; the third, *tochili*, whom they paint with a rabbit's

head, for by this term they name a rabbit; the fourth, *acal*, which they represent as a sign for water. They reckon with these four numbers and objects till they come to the thirteenth year, which then rounds the great cycle, like the indiction or lustrum of the Romans; and when finished four times thirteen, the four years being run four times thirteen, making fifty and two, this they call an age (epoch), and when fifty and two years are ended, with much pomp they celebrate *the great year*, and place the period with those already passed, and re-commence anew their four year computation; the festival of which and the entrance into the new cycle was celebrated among the Mexicans by extinguishing all the lights that existed, and the priests would go to seek light again at a temple situated on a high mountain near *Estapalapa*, where the ceremonies took place, about two leagues distant from Mexico. They then continued henceforth their count of four years, and then of thirteen, till they had reached their fifty-two, and so on from fifty-two to fifty-two for all time.

Returning to the giants who were created at the time when *Tezcatlipuca* was the sun, it is said that when he ceased to be the sun, they all perished, and tigers made an end to them and ate them up, so that no one remained; and these tigers were created in this fashion; that after thirteen times fifty-two years had passed *Queçalcoatl* became the sun, and *Tezcatlipuca* ceased to be it, because he gave him a blow with a great stick, and threw him over into the water, and there he was metamorphosed into a tiger, and issued forth thence to slay the giants; and this appeared in the heavens, for it is said that the *ursa major* came down to the water because he is *Tezcatlipuca*, and was on high in memory of him.

In these eras the Maceguales ate the nuts of the pine trees and nothing else, which lasted while *Queçalcoatl* was the sun, during thirteen times fifty-two years, which was 676 years, which being come to an end *Tezcatlipuca*, on account of being a god did the same actions as his other brothers, and hence was made a tiger, and gave a kick in the breech to *Queçalcoatl*, which upset him and finished his term of being the sun; and then a terrible wind arose which carried away all the Maceguales, except a few who remained suspended in the air, and the rest turned into apes and monkeys; then *Tlalocatecli*, the god of the lower regions, became the sun, and remained so seven times fifty-two years, which are 364 years, in which time the Maceguales had nothing to eat, but *açiçiutli*, which is a species of seed of a grain which is born in the water. When these years were over, *Queçalcoatl* sent down a rain of fire from heaven, and deprived *Atlalocatecli* of being the sun, and made his wife *Chalchiutlique*, the sun in his place, who remained so six times fifty-two years, which are 312 years, and during that time the Maceguales ate only a seed of a grain like maize named *cintrococopi*.[19] And so from the birth of the gods to the fulfillment of the sun according to the count were 2000 and 600 and 20 and 8 years.

Chapter 5th.

Of the Deluge, and of the Fall from Heaven and of the Restoration.

In the last year of the sun *Chalchiutlique*, as has been told, it rained so much water and so great an abundance thereof that the heavens themselves fell, and the waters carried away all the Maceguales that were, and from them were made all manner of the fishes that exist at the present day; and so there ceased to be any more Maceguales, and the heaven itself had ceased to exist, for it had fallen upon the earth.[20] And when the four gods had seen that the heaven had fallen on the earth, which took place in the first year of the four after the sun had ended, and the rain had fallen, which was the year *tochili*, they ordained that all the four should make through the centre of the earth four roads by which to enter it in order to raise the heaven, to assist in which task they created four men; one they called *Cotemuc*, another *Yzcoaclt*, another, *Yzmali*, and the fourth *Tenesuchi*. These four men having been created, the two gods, *Tezcatlipuca* and *Quiçalcoatl*, then formed themselves into enormous trees,[21] *Tezcatlipuca* becoming the one known as *Tazcaquavilt*, meaning the tree of the mirror, and *Quiçalcoatl*,'the *Queçalhuesuch*, and gods and men and trees together raised on high the heaven and the stars, just as they are to-day, and as a recompense for having raised them, *Tonacatecli*, the father, made them lords of the heaven and the stars; and when the heaven was raised, *Tezcatlipuca* and *Quiçalcoatl* walked through it, and made the road which we now see there, and met in it, and remained there in it, and held their abode there.

Chapter 6th.

What happened after the Raising of the Heaven and Stars.

After that the heaven was lifted up, the gods renewed life to the earth which had expired when the heaven fell upon it, and in the second year after the deluge which was *acalt*, *Tezcatlipuca* altered his name, and changed himself into *Mixcoatl*,[22] which means viper of snow, and for this reason he is painted among the gods a viper. In this year he desired to feast the gods, and for this purpose drew a light from the rods whence they were in the habit of drawing it, and hence the origin of drawing fire from flint, which are rods that have a heart. The fire being once drawn, it was the festival of making many and large flames.

From this second year in which fire came forth until the sixth, nothing happened noteworthy, except that in the sixth year after the deluge *Çinteul* was born, son of *Picenticli*, eldest son of the first man, who, because he was a god and his wife a goddess, being made of the hairs of the goddess mother, could not die; two years later, which was the eighth year after the deluge, the gods created the *Maceguales*, just as they had formerly existed, and there is no record of any other event till this cycle of thirteen years was accomplished. In the first year of the second cycle of thirteen years thereafter all the four gods came together and said that the earth had no light

but was in darkness, there being nothing else to give any light save the fires, so they created a sun to illuminate the earth, and this sun should eat hearts and drink blood; so to feed it they were obliged to carry on continual warfare to obtain for it blood and hearts. And since it was the will of all the gods that it should be so, in the first year of the second cycle of thirteen, which was the fourteenth after the deluge, they made a war which lasted two years till it was finished; again in three years they made war, in which time *Tezcatlipuca* created 400 men and five women, so as to have some people for the sun to eat,[23] these men lived only four years after which the women were the sole survivors. In the decennial year of this second thirteenth it is said that *Suchiçicar*, first wife of *Piçiçiutecli*, son of the first man, died in the war, being the first woman to expire in warfare, and much the next powerful of all women, so many as died in war.

Chapter 7th.

How the Sun was made and what took place afterwards.

In the thirteenth year of this second cycle of thirteen, which is in the twenty-sixth year after the deluge, we have seen how the gods agreed to make the sun, and how they made war in order to give it something to eat, *Quiçalcoatl* wanted to make his son the sun, of whom he was the father but who had no mother, and at the same time *talocatecli*, the god of water, made to himself a son by *Chalchiutli*,* his wife, which is the moon, eating nothing until (*here there is a lacuna in the original*), and they drew blood from their ears,[24] and with this they fasted, and they drew blood from their ears, and their body in their prayers and sacrifices; and this being done *Quiçalcoatl* took his son and heated him red hot in a great fire, from whence he issued as a sun to illumine the earth; and after the fire died out, *Talocatecli*,[25] came and threw his own son in the cinders from whence he issued forth as the moon, for which reason he appears ashy colored and obscure. In the last year of this thirteen, the sun began to give his light, for before that time it had always been night, and the moon began to run after the sun, and never to catch up with him, and they traversed the air perpetually without ever arriving at the heavens.

Chapter 8th.

Of what happened after the Sun and Moon were made.

One year after the sun was made, which was the first of the third thirteen after the deluge, Camasale, one of the four gods, went to the eighth heaven, and created four men and one woman for a daughter, so that they should go to war, that there should be hearts for the sun and blood for it to drink: and being made they fell into the water, and then returned to heaven, and as they fell and there ensued no war, the next year, which was the second of the third thirteen, the same *Camasale*, or as he is sometimes called *Mixcoatl*, took a rod and struck with it on a rock from which sallied forth forty *Chi-*

*See Note 12.

chimecas,[26] and this they say was the beginning of the *Chichimecas*, which we call *Otomis*, which in the language of Spain signifies mountaineers, and these, as we shall narrate hereafter, were the inhabitants of this country before the Mexicans came to conquer, and to dwell there; and in the eleven years following of this third thirteen, Camasale[27] did penance, taking the thorns of the maguëy and drawing blood from his tongue and ears, and for this reason it is the custom to draw blood from such places with the thorns whenever they supplicate the gods. He did this penance so that his four sons and daughter that he had created in the eighth heaven should descend and slay the *Chichimecas*, so that the sun should have hearts to eat; and in the eleventh year of the third thirteenth, down came the four sons and the daughter, and placed themselves in some trees whence they fed eagles; and now it was that the *Camasale* invented the wine of the maguëy and other kinds of wines in which the *Chichimecas* busied themselves, and knew nothing better than drunkenness; and being in the trees the sons of *Camasale*, they were seen by the *Chichimecas*, who went to them, so they descended from the trees, and slew all the *Chichimecas*, only three escaping; one was called *Ximbel*, another *Mimichil*, and the third was the *Camasale*, the god who had created them, and who transformed himself into a *Chichimeca*. In the eighth year of the fourth thirteen after the deluge there was a great noise in the heaven from whence there fell a deer with two heads, and *Camasale* caused it to be caught, and ordered the men who then inhabited *Cuitlalavacu*, three leagues distant from Mexico, that they should capture that deer and regard it as a god, and they did so, and they gave it for four years to eat of rabbits and vipers and butterflies; and in the eighth year of the fourth thirteen *Camasale* had a war with some of his adjoining neighbors, and in order to conquer them he took the aforesaid stag and carrying it to them overcame them; and in the second year of the fifth thirteen did this same god *Camasale* celebrate a festival in heaven, making many fires; and until there was completed the fifth thirteen after the deluge did *Camasale* keep on continuously making war, and with it he gave nutriment to the sun.

They say, and the paintings likewise show it, that in the first year of the sixth thirteen the *Chichimecas* waged war against *Camasale*, and took away his deer, through which he was enabled to be victorious; and the reason why he lost it was that while wandering about the field he fell in with a female relation of *Tezcatlipuca*, a descendant of the five women whom he had made at the time when he created the 400 men which latter died, but the females remained alive, and this one was descended from them, and bore a son who was known as *Ceacalt*;[28] and in this thirteen they represent that afterwards when *Çeacalt* (*sic*) was a youth he did seven years of penance, wandering alone through the mountains, and drawing blood from himself that the gods might make him a mighty warrior. And in the sixth thirteen after the deluge began, this *Çeacalt* to wage war, and he was the first lord of *Tula* whose inhabitants chose him for their chief on ac-

count of his valor. This *Çeacalt* lived until the second year of the ninth thirteen, being lord of *Tula*, and four years before that time he built a very large temple in *Tula*, and when he had done it there came to him *Tezcatlipuca*, who told him, that towards *Honduras*, in a place which is now called *Tlapalla*, there was a house built for him, and that there he should betake himself and breathe his last, for that he must go away from *Tula*,[29] in which town *Çeacalt* was reverenced as a god; to what *Tezcatlipuca* said to him, he replied that the heavens and the stars had told him that it was his fate to leave there within four years. And so when these four years were completed, he departed and took with him all the *Macegualee* of *Tula*, and left them at the city of *Chulula*, whence are descended all its inhabitants, and others he left in the province of *Cuzcatan*, whence descends the present population of that place, and in the very same manner he left behind him in *Çempoal* others who settled there, and he proceeded on his journey till he reached *Tlapala* (*sic*), and on the very day in which he arrived there he fell ill, and on the day following he died. Then *Tula* remained depopulated, and without a lord nine years.

Chapter 9th.

Of the beginning and coming of the Mexicans to this New Spain.

It is said that after the completion of ten thirteens after the deluge, which are 130 years, the Mexicans were settled in a community named *Azcla* to the west of the New Spain slightly trending toward the North, which was very much populated, and in whose centre stood a mountain whence issued a fountain which became a river, like *Chapultepeque*[30] is in Mexico, and on the other side of this river was another settlement, and a very large one, named *Culuacan*;[31] and since their computation begins with the first year of their emigration, so from now on for the future we shall reckon time starting from the year in which this Mexican agreed to sally out to find new lands that they might conquer, and for that reason they chose three war chiefs or captains, one they named *Xinçi*, another *Tecpaçi*, and the third *Coantlique*, and with these three started off many Mexicans (the paintings do not set out their number), and they carried with them the figure and manner of constructing their temples, so as to be able to erect them to *Vchilobi* wherever he should come. So they took their adieu of the temple they had in *Azcla*,[32] and began their journey, for which reason the painting representing their expedition, makes its beginning with the temple.

Chapter 10th.

How they Departed, the People of Culuacan, and what Peoples went with them, and how they were named.

As has been already narrated on the eastern side of the river they represent the City of *Culuacan*, a very large city with many populous places around it filled with people, on the account of which the inhabitants determined

to seek a country to settle in, and being united they took for captain and war-chief one named *Ynqualtlatlanqui*, and they took the namės of the old towns and places they had left, and gave them to new ones in the country to which they immigrated. It is said that the following people went with them, and each one took its own god which it worshiped, and the manner of its own temple, for in each one the service was different, and no one was identical with another, for which reason they are painted dissimilar; and so there went forth with them those of *Culuacan*, which was the principal city, and was placed in the new settlement distant two leagues from the one whence they populated it as they came. of which more will be said in the hereafter. They took their gods. named *Çinteul*, son of *Pinçetecli*, *Suchimulco*[33] went with them, taking his god named *Quelazcli*, who was the stag of *Mixcoatl*[34] as has been told; *Atitlalabaca*, went forth with his god *Amimicli*, which was a rod of *Mixcoatl* whom they reverenced as a god, and carried that rod in memory of him; *Mizquique*, went forth with *Quiçalcoatl* as his god; *Chalco*[35] went forth with *Tezcatlipuca napatecli* for his god. The people went forth of *Tacuba*, and *Culucan* and *Ascapuzalco*, which was called *Tenpanecas*,[36] and these took as their god *Ocotecli*, which is fire, and for this reason they are accustomed to consume in the fire all whom they capture in war. These people, say the Mexicans, and no more sallied forth, although those of *Tazcuco*[37], and *Tascala* and *Guejoçingo* boast and vaunt themselves that they too came when the others came from Mexico, and are also of that land. All these people with their gods set out in this first year, which was *tecpalt*, and there went forth of them forty bands.

CHAPTER 11TH.

Of the Road they journeyed and of the Places they went, and of the Time they tarried in each Place where they were.

All having departed they came to two lofty mountains, in whose midst they encamped and remained there two years, and as the days are not painted that they occupied in reaching this spot, nothing appears more clearly than that up to the time of their resting in these sierras they reckon one year, and two years they spent there sowing what they had to eat and carry off with them, and here they erected their first temple to *Vchilobo*, according as they had done in that city.

These two mountains stood opposite each other, and their habitation was in their middle.

After three years had passed since their departure from *Astla* (*sic*), from when the Mexicans came forth, as has been told, they left the place or site of the two hills where they had remained two years, after having built a temple to *Uchilogos* (*sic*), as has been said, and came to a valley where there were many great trees, which they named *Quaustiteaca*,[38] on account of the many pine trees that were there, and there they stayed a year, which completed the four years since they had left their homes.

Thence they traveled onward till they came to a place which they named *Chicomuxtoque*,[39] and they settled there and remained nine years, and so here they completed the thirteen years from the time of their departure, and when they left there they laid the place waste; and there was born in this place, *Tlacuxquin*, and *Mançamoyagual* and *Minaqueciguatle*, who were the two males, and one woman, their chief personages, and here was accomplished the thirteenth year of their exodus, and they began to reckon the second thirteen.

When they had departed from *Chicomuztoque* (*sic*), they came to a plain, which is the spot where at the time dwelt the *Chichimecas*, whose home was in front of *Panuco*, and here they remained three years, and to this valley they gave the name of *Cuatlicamat*. At the end of the three years they went forth and came to a ranche which they called *Matlauacala*, where they dwelt three years, and erected a temple to *Vchilogos*, thence they came to another ranche, named by them near the one where the *Otomies* lived, the indigines of the land; and here they rested five years, and erected another temple to *Vchilogos*, and here was fulfilled eleven years of the second thirteen since their departure.

From this sojourning place they came to a mountain opposite *Tula* named *Coatebeque*,[40] and when they came the *Muçeguales* held in great veneration the mantas of the five women whom *Tezcatlipuca* made, and who died the day the sun was created, as has been said, and from these mantas the aforesaid five women came again to life, and wandered in this mountain, doing penance, drawing blood from their tongues and ears; and when four years of their penance had passed by, one named *Quatlique*[41] who was a virgin, took a small quantity of white feathers and placed them in her bosom, from which she conceived without having known man, and there was born of her *Vchilogos*, for a new birth, in addition to his other nativities, for he was a god all-powerful, and could do whatever he wished.

And here came again to life the 400 men whom *Tezcatlipuca* created, and who died before the sun was made, and when they saw the woman was pregnant, they sought to burn her, but *Vchilogos* was born of her fully armed, and slew the whole of the 400 men; and this the feast of his nativity and the slaughter of the 400 men they celebrate every year, as will be narrated in the chapter relating to their festivals; and before the feast there is a great general fast who shall participate, lasting eighty days, during which they only eat once a day; and these 400 men whom *Vchilogos* slew, the inhabitants of the province of *Cuzco*[42] burnt up and took for their gods, and reverence them as such down to the present day, and in this way they celebrated for the first time the festival of the birth of *Vchilogos* and the massacre of the 400 men by him.

When thirty-three years had elapsed since their departure from their home, they went forth from *Coatebeque* and came to *Chimalcoque*, where they remained three years; thence they came to *Ensicox*, where they dwelt another three years, and built a temple and placed the mast of *Vchilobos* (*sic*); and after the thirty-ninth year from their departure they

drew out the mast of *Vchilobos* (*sic*), and gave it to *Vingualti*, to carry it with the greatest veneration on their journey, and they came to *Tlemaco*, which is near to *Tula*, and raised a temple to *Vchilogos* (*sic*), and remained there twelve years, and these twelve years being passed, they departed thence and took up the mast of *Vchilogos*, and gave it to *Caçiçi* to carry. And after all this had happened, they came to *Tlitlalaquia*, a well known town, and it was on the borders of *Tula*, where they rested two years and built a temple to *Vchilogos*; and after these two years the Mexicans came to the town of *Tula* itself, which in these days was peopled with its aborigines, who were the *Chichimecas*, and when they came to the said town they erected a temple to *Vchilogos*, and placed before it the candelabras that are now in use, in which they placed cepal and other savory things; and as soon as the Mexicans had come *Vchilogos* appeared to the inhabitants of the country in a black form, and they heard *Vchilogos* wailing beneath the earth, and they asked wherefore the god of the Mexicans was weeping below the ground, and the answer because every inhabitant of *Tula* was doomed to death. Four years later, an old woman, a native of *Tula*, went about giving out flags of paper fastened to rods, and making it manifest to them that they should get ready to die, because their time had come; and presently they all cast themselves upon the stone on which the Mexicans were wont to offer up their sacrifices, and the one of them who took charge of the temple which was in Tula, by name *Tequipuyul*, who was a stranger and a vagabond without employ, and whom they believed to be the devil, slew them all; and before the Mexicans erected their temple, that stone was a temple to the inhabitants of Tula; and so were put to death all the inhabitants of Tula, so that not one remained alive, and the Mexicans were lords of Tula.

Departing afterwards from Tula they came to the place where now stands the town of *Atotoniltengo*, where they remained one year, and thence they came to the town of *Tecuzquiciac* where they rested four years; thence they came to the town of *Apazco*, and from *Pazco* (*sic*) to *Zumpango*, where they stayed three years, and as they arrived near the town of *Çumpango* (*sic*), they encountered one sole *Chichimeca*, named *Tlavizcal Potongui*, who went out to meet the Mexicans, as he saw them coming; and they sacrificed to *Vchilogos*, god of the Mexicans another *Chichemeca*, whom they had made prisoner in battle, and they placed his head upon a pole for which reason this town is called *Zumpango*, which signifies a pole that transfixes human heads. Thence after four years they departed and came to *Tlilac*, where they tarried seven years, and leaving there, as they were on their road to *Clautitlan*, they lost one of their women who had been captured by the *Chichimecas*, and taken to *Michuacan*, and from her were born all the dwellers in *Michuacan*, who before that time were all *Chichimecas*, and they pursued their road to *Quatitlan*, where they were one year. Thence they proceeded and come to *Ecatebeque*, where they stayed one year, and when they left *Catebeque* (*sic*), they reached *Nepopoalco*,

which signifies a narrow passage where a shepherd can count his flocks for here they took the number of those who came; and no one knows how many there were of them, nor is there any memorial of the number in their paintings. Here they built a house to *Cipan* and to *Xincaque*, who were those who took the census of the people as they came, and from here went forth three Mexicans, one named *Navalci*, another *Tenaçi*, and the third *Chiautotolt;* and these three went forth to settle *Marinalco*, a town that exists at this day; and being there the Mexicans built a temple to *Vchilogos* at *Çimalpal*, two leagues from the City of Mexico, and then the Mexicans gave the name of *Tlatlatevique* to a mountain near *Chimalpa*, and thence they came to another mountain named *Quatitlan* which is two leagues from Mexico, where they rested four years, and thence they came to a mountain named *Visachichitlan*, where at the present the inhabitants of the suburb of Santiago live, thence they came to the mountain called *Teubulco*, thence to *Tenayucan*, and here a leading Mexican died, *Tepayuca* or *Tehayuco*, which was his name, and they found a *Chichimeca* in this place for their ruler named *Tloçi;* here they raised a temple to *Vchilogos*, and sacrificed a woman and made a grand festival, taking her there highly ornamented, as was their custom when they offered up a woman-sacrifice. Having made the feast to *Vchilogos*, they departed and came to a mountain named *Tepexaquilla* where they settled for nine years; and when the nine years were passed, they descended from this mountain, and dwelt near a lofty rock which issues warm water, now known as *El Peñolcillo*, which divides the suburbs of Mexico and Santiago, and all was barren up to the said rock, and there flowed the stream of Chapultepeque, and they made a certain enclosed place of chalk and stone to keep these waters, and they dwelt by them for four years; thence they came to Chapultepeque, where they gave a direction to the stream, and placed behind it many rods with pennons such as the old woman gave to the people of Tula, when they wished to sacrifice themselves, for which see what has been already narrated; then the Mexicans ceased being in *Chapultepeque*, and went forward and came to *Tlachetongo*, which is now *San Lázaro*, near to *Tianguez* of the Mexicans, and thence they proceeded to the suburb called *Aqualcomac*, which is nigh to the said *Tianguez*, and thence to *Vetetlan*, and thence to *Ixocan*, which is the road of *Cuyacan*, and thence they came to *Tenculuacan*, where at the present they make salt, and thence to a mountain named *Tepetocan*, which is near to *Cuyoacan* (*sic*), and thence to *Vchilobusco*, distant two short leagues from Mexico, named *Ciavuhilat* in the *Chichimeca* tongue, because it was peopled by them, and in their religion they worship *Vbuchilti*, who was the god of water; and this god of water met* the Indian who carried the mast and plumes of *Vchilogos*, and as he did so he gave him certain arms which are those with which they slay the water fowl, and a dart; and because *Vchilogos* was left-handed as well

* *Topó* means, first, to meet; second, to strike. It may be that it should read "touched."

as was the god of water, they said that it must be his son, and the four were close friends, and they changed the name of the town where they had met with him, which was formerly called *Vichilat*, so that for the future it was known as *Vchilobusco*.

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From thence they came to Culuacan, where they found for ruler *Achitomell*, and then they passed onwards to the mountain named *Visachitla*, which stands near *Estapalapa*, and from there they came to *Quesumalc*, where they dwelt three years; and thence they went to *Capulco*, and made a detour to *Tacuxcalco*, which is the road of *Talmanalco*, where they built a temple to *Vchilogos*, and all the Mexicans assembled together at this place, *Tacuxcalco*, *Xinteça* and *Caley* and *Escualt*, being their war-chiefs, and they spoke to all the people; and because the *Chichimecas*, the aborigines of this land would not join themselves against them, but divided themselves off into many places, and in order not to be recognized altered their fashion of wearing the hair, so it was all done; because as they said *Vchilogos* had commanded them to act in this manner, and every one of those who went away, carried off his weapons, and those who remained took the plumes and deer skin of *Micoatl*, and his darts for arms, and the sack into which he was in the habit of throwing wild figs, because in those days people ate nothing else; then they kept on still farther to adjoining places in the neighborhood, and the war-chiefs addressed the people, telling them that four years they had to be dispersed, hidden and at the end of the said time they should all be reunited at *Cacaquipa*; and when the four years were passed they came together and returned to the mountain and bridge[43] of *Chapultepeque*, and there they captured *Copil*, the son of the woman whom the *Chichimecas* had taken prisoner, whence descends the people of *Mechuacan*, and they offered him up as a sacrifice, tearing out his heart towards the sun, and they remained dwelling in *Chapultepeque* fifteen years.

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Whilst they remained in *Chapultepeque* they had three war-chiefs,[44] one named *Clautliqueçi*, son of the chief who brought them, and was known by the same name, as has been told, and *Acipa*, son of *Çipayiavichiliutl*, son of *Tlauizcal Potongui*, and they chose this latter as their ruler to rule over them, and he governed them all the fifteen years they were in *Chapultepeque*. This *Vichiliutl* (*sic*), had two daughters, one named *Tuzcasuch*, and the other *Chimalasuch*; and, as we have already narrated, there was sacrificed in *Chapultepeque*, a son of the woman whom the *Chichemecas* took to carry off to *Mechuacan*, whence are descended those of *Mechuacan*, so they say that in this place also the aforesaid son of the said woman came to Mechuacan to see two Mexicans,[45] and when they wanted to sacrifice him, he said that he was not to be sacrificed except in *Mechuacan*, where his mother was, so over that they had

a fight by command of *Vichiliutl* and *Quatliqueçi*, and conquering him offered him up for sacrifice, and buried his heart in a place called *Tenestitan*, which was a City of Mexico, afterward founded in this place, and the head they interred in *Tluchitongo*.

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These nine years being passed, they rested likewise twenty-five years additional in peace and quiet, *Vichiliutl* governing them, and they built on the hill of *Chapultepeque* a grand temple to *Vchilogos*; and while they were here, the Mexican aborigines, who were all *Chichimecas*, joined themselves together and assaulted them, and sat down their camp to besiege them near to the southward of *Chapultepeque*, and when night came on they fell upon the Mexicans and slew them, so that but few escaped by flight and took refuge among the canebrakes and recesses of the lagoon which was near by; and they burnt the temple which had been built, and the people of *Caltoca* captured the two daughters of *Vchiliutl*, and carried them away captive; and also was *Vchiliutl* taken prisoner, and the men of *Culuacan* slew him after he was captured; and those who fled and escaped were hidden for eighty days in the canebrakes, and ate nothing but herbs and vipers, and they bore with them *Vchilogos* being (*here occurs apparently a lacuna in the MS.*).

CHAPTER

We have told how the heart of *Copil*, the son of the woman who went to *Mechuacan** was interred at *Tinustitan*, and the reason why was that one day when *Coautliquezçi* was standing beneath a hut built of branches there appeared before him *Vchilogos*, and ordered him to bury the heart in that place, for in that place was to be his home, and he went there for that reason, and was buried there.

CHAPTER

When all the aforesaid had taken place, the Mexicans who had been in hiding among the canebrakes and herbage were driven out by the great hunger they felt, and came to *Culuacan* to seek for food; and they told the people of that place when they reached there that they had come to serve them, that they should not slay them, and they prayed to *Vchilogos*, for him to give his orders that they should not be put to death; and they gave to the men of *Culuacan* the plume and the staff of *Vchilogos*, and remained in their service. In these days *Achitomel* was lord of *Culuacan*, and *Chalchiutlatonac* the chieftain, and they had a very fine temple in which the people of *Culuacan* celebrated a feast to *Çiguacoatl*,** the wife of the god of the infernal regions, whom the people of *Culuacan* reverenced as their especial god.

CHAPTER

For the space of twenty-five years the Mexicans remained under the dominion of the people of *Culuacan* during which time the people of *Cul-*

* Mechoacan, El tierra de pescado (Garcia, v, 325).

uacan waged warfare against the people of *Suchimilco*, and in order to prove if the Mexicans were really warriors, they ordered them to go with them to help them; and the Mexicans thinking they were regarded as women, sent ten Mexicans, and no more, with them to the war, and the remainder stayed in their houses, which they possessed in *Tiçapan*[47], at that time a domain of *Culuacan*, and they gave orders to the ten men who went, that they should not slay any of the Suchimilcans, but that they should make them captives and cut off their ears; and the ten Mexicans did as they were directed so well, that they made prisoners of eighty of Suchimilcans, and from whom they cut off the ears, and from this the men of *Culuacan* recognized that the Mexicans were men of war.

Chapter

At the end of the aforesaid twenty-five years the Mexicans left a temple which they had built to *Vchilogos* in *Culuacan*, and erected another very large one at *Tiçapaa*[47], and when the Culuacans saw so grand a temple they asked the Mexicans what they were going to have in that temple, and what they should place in it; to which they were answered *hearts*, and when the Culuacans heard this reply, they threw straw and filthy things into the temple, mocking at the Mexicans. Then the Mexicans[47*] who was called *Avençi*, and sacrificed her to *Vchilogos* smeared blood on the walls with one of her legs; and when the *Culuacans* saw this sacrifice they were astounded, and arose against the Mexicans, and they all ran near to *Catitlan*, a river which flows close to *Culuacan*, and kept on flying all the way to *Nextiquipaque* in which place at this day there are ten households that are subject to Mexico, and *Ooxcoçi*, chief of *Culuacan*, looked favorably upon the Mexicans, and because they had risen against the Mexicans, he slew many Culuacans.

Chapter

When all the aforesaid twenty-five years already written about had elapsed, there began the first year in which they commenced to enter into the bounds of *Tenustitlan*, Mexico, and to populate it, and they came to *Istacalco*, which is a country near Mexico, and thence they went to *Mixuacan*, where a woman bore a child to which they gave this name, which signifies the fertile, and from there they settled in a suburb named *Temazcaltitlan* which signifies the suburb of the bath, and is in these days the district and suburb of St. Peter and St. Paul, and in the place it said that some Mexicans who carried *Vchilogos* went astray, murmured against him, and *Vchilogos* told them in their dreams that things must be as they had been, but that they were near to the place where they were to take their final rest and home, and that those who had murmured against him had sinned like men of two faces and two tongues; and in order that they should obtain pardon, they made themselves a head with two faces and two tongues, and having made the head of it of the grains that they ate, they shot arrows at it, and covering up their

eyes, those who had shot at the figure, sought to find it, and finding it they ate it up, dividing it up among them all; and so it was performed, and they all came together and settled in *Tatiluleo*, which was a small island, and is now known as the suburb of Santiago. In this first year in which the Mexicans came to the aforesaid place, *Vchilogos* appeared to one of them named *Tiunche*, and told him that his home was to be in this spot, and that the Mexicans would not have to wander any farther, and he should tell them that when it was morning they should go seek a man of Culuacan, because he had abused them, and take him and sacrifice him, and give him to the sun to eat. So *Xomemitleuts* went forth and found a man of *Culuacan* named *Chichilquautli*, and sacrificed him to the sun on going out; and they named this place *Quanmixtlitlan*,[48] which afterwards was called *Tenustitan*, because they found there a wild fig tree grown on a stone, and the roots thereof grew forth out of the place where lay buried the heart of *Copil* as has been already narrated.

CHAPTER

In the second year of the settlement of Mexico the Mexicans began to lay the foundations of the large and important temple of *Vchilogos*, which kept on increasing at a great rate, for every ruler of the dwellers in Mexico who succeeded another in power added to it a building equally as large as the original one which the first inhabitants had erected there; and this the Spaniards found very tall and strong and broad, and it was much to look at.

In these days the Mexicans had for their ruler *Illancueitl*, a woman of importance who had power over them; and she was the wife of *Acamapichi*,[49] a native of *Culuacan*, and she was of *Coatlixan*, and although of *Culuacan*, descended from the Mexicans, for her mother married there one of the chief men of *Culuacan*, and the mother was a Mexican; and her husband, at the suggestion of his wife, came to Mexico, and she told them that as he was of the best family and they had no lord, they should take him for their ruler, and so he was the first ruler, and his wife died in twenty-fourth year after the foundation of Mexico; and after her death they chose him for lord because in her life he was only looked upon as the chief man;[50] three years before this, which was reckoned as twenty-one years from the foundation of Mexico, the Mexicans made war upon the people of Culuacan, and burnt their temple. In the next year, the twenty second from the foundation of the city, the Culuacans took notice of the great progress the Mexicans had made in those twenty-two previous years, and were smitten with fear, and placed their gods in a canoe with which they went to *Suchimilco;* and when they had reached the town of *Cuantlecaxtlan*, the sun shone forth with so much brilliancy that his rays struck them blind, and so they could not see until they had come close to Mexico; and when they had recovered their sight they placed their gods in Mexico, and built for them a small temple a short distance further on than the place where now stand the shambles.

In the twenty-eighth year from the foundation of the city in which the fifty-two years were fulfilled, there was held a great public festival in which all light was extinguished throughout the land, and when it was all extinct they would draw fire anew from the mountain of *Estapalapa*. This festival took place from every fifty-two to fifty-two years, so that the year that completed the four times thirteen years was the fifty-second one.

At the thirty-first year from the foundation of the city fire first began to issue forth from the volcano, and in the forty-seventh the Mexicans conquered *Tenayuca*, and burnt its temple, which was of straw, and the people of *Tenayuca* were *Chichimecas*.

In the fifty-second year of the foundation of the city the people of *Tatilulco* petitioned for a ruler *Teçuxomutli*, the lord of Escapuçalco, and he gave them for their master *Teutleuac*, whose rule did not endure forty days, for he bore too hardly upon their braves, and they helped him in no manner. *Teçucumutli*, who was a Mexican, was chosen for their lord by those of *Escapuçalco*, as one of the two which it was their custom to have, and they have always had that number, and have to this day.

Quaquanpuanaque was the second ruler of the Tatilulcans whom the lord of *Escapuçalco* gave them; his reign lasted fifty days, at the end of which time they fled away from him; he is represented with claws on his feet. In the fifty-third year of the foundation, *Acamapichi* was made ruler of Mexico. In the fifty-sixth year the Mexicans made war upon the *Suchimilcans*, and burnt their temple; and in the year 59 *Acamapichi* conquered *Mezquiqué*. In the year 63 from the foundation of the city there went forth from Mexico forty men and women by *Guaximalpan*, and the *Otomis* of *Matalçingo* found them, and slew them by treachery in *Cuitralavaca* (*sic*).

In the seventieth year from the foundation of the city *Acamapichi* conquered *Cuitralavaca*, and burnt for them their temple. In the seventy-third year Lord *Acamapichi* died, and they made *Vichilivci*, the son of Acamapichi, their ruler. In the year 75 *Miciuçixiuci*, the daughter of *Escoaçi*, lord of *Cuernavaca*,[51] wife of *Viciliuçi*, bore *Mutiçuma*, the elder, who first was called *Iluican Minaçi*, and afterward *Mutiçuma*; because his father was lord against the will of very many people, the son changed his name into *Mutiçuma*, which signifies *angry lord*. In the year 79 a sister of *Viciliuçi* married with *Istlisuchilci*, lord of Tezcuco, and bore *Neçavalcuyuci*, who became lord of Tezcuco. In the year 81 the Mexicans conquered *Quaximalpan* from the Otomies.

In the year 85 from the foundation of the city the Mexicans conquered *Capiscla*, and in the same year *Quanximilco*, in the province of Chalco, and in the next year they waged war against all the aforesaid peoples, and in that year they gave themselves up. In the ninetieth year from the foundation they conquered *Tezquiaque*. In the ninety-second year the Mexicans sent out seven of their chieftains to ascertain if the peoples of *Puchitlan* were for war, and as they passed by *Xaltocan* three of them were treacherously made captive and murdered, and the other four escaped by

flight. In the next following year they conquered the province of *Tascuco*, and they began upon *Tepepan*, much against the wishes of its ruler, who, when he saw them, went away and fled to *Tesmuluco*, a town of *Suyocingo;* the father (*here occurs a lacuna*) being dead, because they were at peace with the Mexicans.

In the following year 94, *Viçiluicin* died, and they took for their lord a brother of his named *Chimalpupucaçi*. In the year 97 the people of *Tascuco* gave themselves up to *Chimalpupucaçi*, and in the same year they captured Tulançingo, and the Mexicans were a whole year in making themselves masters of it. In the year 99 the people of *Tatiluco* fled to *Tula*, and as they had died out, and had left their god, named *Tlacauepan* there, so they took him and carried him to *Tatilulco*. In the year 105 from the foundation of Mexico, *Teçocumuc*, lord of *Escapuçalco*, died, and as *Maxtlato*, son of *Çocumuc* was lord of *Cuiuacan* in the lifetime of his father, and as his father was now dead, he came to be lord of *Ecapuçalco;* and this one gave orders that there should be a general uprising against Mexico, and when *Ximalpupacaçi* saw that the land was in rebellion, he slew himself, and being dead the Mexicans chose as their lord one of his brothers named *Iscuaçi;* and when *Tlacateulti* lord of *Tatilulcoco* saw the great force and command that the lord of *Escapuçalco* had, he fled away from him, but to no avail, for he was captured near the fountain of *Saltoca*, and there they slew them; and it was because formerly, when he was lord of *Escapuçalco*, the lord of Tatiluco seduced his wife, and for that reason the captive was ordered to be slain; and in this year *Neçagualcuyuci* fled from *Tezcuco*,* because the Tezcucans were in revolt against Mexico. In the following year 106, the natives of the country endeavored to make war against Mexico, by order of the lord of *Escapuçalco*, but one of the chiefs of *Escapuçalco*, named *Totolayo*, made peace with Mexico in the year 108, and the inhabitants of Mexico would not permit of a peace unless they slew the lord of *Escapuçalco*, and seeing how on account of their desire for a peace they could do no other thing, they caused him to be slain, and so it was done (*In the year 109 Tatilulco rose in revolt*), and in the year 112 they came into conflict with the Mexicans. In the next year, 113, *Quautlatoaçi*, the lord of *Tatiluco* (*sic*), revolted against Mexico, and one night in his dreams there appeared to him one of the gods they worshiped who told him he had done wrongly, and for this reason he rendered himself up at Mexico, and the Mexicans were unwilling to slay him, so they handed him over to his own people that they might put him to death, and so they killed him. In the 117 the Mexicans gained *Guautitlan*, and in the next year *Izcoaci* died, and they raised to be their lord *Mutiçuma*, the elder. In the year 125 of the foundation of Mexico, *Vchilobos* (*sic*), renewed himself, and made himself enormous.

In the 128 at the Easter-of-Bread season there fell such a terrible hail, and so much of it that the houses were destroyed and fell in ruins, and the lagoon froze up. In the year 132 there was terrible hail and famine, so much

* *Tetzcuco*, (Molina); *Tetzcoco* (Buschman, 697).

so that in the next year it was ordered that if one took but a thread of maize, even if the maize field belonged to him, he should die for the act. In the year 136 *Moteçuma* the elder, having made a round buckler (or disk*) of stone, the same which Rodrigo Gomez drew forth, caused it to be buried at the door of his house, and placed a hole in the middle of it, and it was a very big hole, and in that hollow they placed the captives taken in war, fastening them to it, so that they could command only their arms, and gave them a shield and a sword of wood, and they brought in three men dressed respectively as a lion, a tiger, and an eagle, and all these fought the prisoner, and wounded him; then they took a large knife and cut out his heart; they made these knives out of stone, under this enormous large and round stone; and afterwards the others who were lords of Mexico made two other stones and placed them, each lord his own, one over the other, and the one they took away[52], and it stands to this day underneath the baptismal font; and the other was broken up and burned when the Spaniards entered, and the very first persons who used this stone were the people of *Cuaistravaca*.

In the year 139 *Oruistravaca* was taken, and much precious stones were brought to *Muteçuma* In the year 141 the Mexicans took *Quetlasta*. In the year 147 *Moteçuma* (*sic*), died, and *Axayacaçin*, his son, was raised to be lord. In the year 151 *Mochiuçi*, the lord of *Tutiluleo*, surrendered himself to Mexico, and in the next year the people of *Quetlastla* revolted on account of the annual tribute of twenty men, and they took refuge in a house filled with red pepper (*agí*), and consumed themselves with fire; but soon in the year 153 they were subjugated. Next year *Axayacaçi* made *Citlalcoaçi* the lord of *Malinalco*. In the year 155 *Axaycaçi* seized three men himself, and was wounded, and so he personally gained *Matalçingo*. The following year, 159, *Axayacaçi* died, and they made his brother, *Tizçoçicaçi*, lord of Mexico.

The following year, 160, they endeavored to make Vchilobi very large, and almost all, even to the infants, set to work on him. Next year they held a festival in the temple of *Vchilovi* (*sic*), with the blood of the *Matalçingos* and *Tlaulans*, for they slew many of them. In the year 164 *Tizcoçicaçi* died, and his younger brother *Auiçoçi* was raised to be lord of Mexico. Next year *Vchilovi* (*sic*) was finished by *Auiçoçi* and he sacrificed many people on that occasion. In 176 the water rose so high in the lake, especially the river of *Cuiuacan*, that all the houses were drowned, and the water came up to the first circle of *Vchilobi*, and the houses which were of adobe fell in; and it is said that the water that rose was black and full of vipers, and it was looked upon as a miracle. In 180 *Aucoçi* (*sic*), died, and was succeeded by his brother *Muteçuma*, who was the last lord. In 182 *Muteçuma* built a temple to *Quiçalcoatla*, where, at the present time, stands the house of the bishop, and covered the roof with straw. Next year the lightning fell on it, and consumed it, 'twas said that the bolt was sped by *Tlaloque*, the god of water. They built a very large temple to

* *Rodela*.

of *Çintelil*, the son of *Piciutetl*. In the year 184 the inhabitants of Mexico slew many of those of *Çoçola*, whom they had captured in war; having stretched them out on two pieces of wood in the form of a St. Andrew's cross, they shot them to death with arrows, and every year they celebrated this festival. In the 185th year from the foundation of Mexico, the fifty-two years were completed, and *Muteçuma* celebrated the festival for the last time. In the 189 there appeared an omen in the heavens, which arose from near the summit of the volcano and floated on high over the city, and it was of a white color as broad as two arms; and *Moteçuma* endeavored to discover what this thing might portend, and his wise men responded that it foretold his decease in that year, and it turned out that this was the very year in which the Christians appeared on their journey to this land. In the year 193 the *Tascalans*[22a] laid siege to *Guaxocingo*, and they were reduced to great straits through hunger, until *Muteçuma* brought them assistance, and took some of them to Mexico, and others of them he placed there for his defence; and they prayed to *Camastle*, their god, and after that they had made an end of prayer, they rose in revolt so that the Mexicans let go their prisoners and returned to the city; and the people of *Guaxocingo* slew the Mexican women who had intermarried with the men of *Guaxocingo*, and all their sons, because they were of Mexican blood.

In the year 196 in *Guaçacalco* (*sic*), came two ships which were received at *Vera Cruz de Paz*, to spy on whom *Muteçuma* sent one of his people, and soon *Muteçuma* said that these were his gods; the ships remained at *Guaçacualco* (*sic*), and said they would return a year later;[23] the day they arrived at *Guaçacalco* was called *centochil;* the port of Vera Cruz bore the name of *Chalchuecan*. In the year 197 came the Marquis to New Spain to whom *Muteçuma* sent an envoy to Vera Cruz with many shields and plumes, and a sun made of gold, and a star of silver; they made themselves understood by the Indians by means of an interpreter named Marina.[24] Afterwards the Marquis came to *Cempoal*, where they received him with trumpets. Thence he proceeded to *Tascala*, where the warriors sallied forth to battle, and all who came forth were slain; and he being informed that the Tascalans desired to massacre the *Chululans*, he joined with them in another place and slew them all. It is said that whilst the Marquis was in *Chulula*, he sent *Alvarado* to the province of *Chalco*, who returned with the information that the land and the people were both bad, and that he should turn back; on which *Tamaya*, the lord of *Çempoal* said that he had better march to Mexico, where *Muteçuma* lived very richly, and that everything he owned was made of gold, and that he styled himself lord. The Marquis was forty days in Chulula. Then there came on the behalf of *Muteçuma*, *Visnagual*, the father of *Tapia*, who was with the Marquis, to tell him by the orders of *Muteçuma*, that he would give him much gold and silver if he would turn home again; him the Marquis caused to be seized which caused great fear to Muteçuma. (In this year 198 was held the festival of *Vchilobi*), and *Muteçuma* died from the effect of a blow with a stone thrown by one of his

own subjects, who would not listen to him, but used opprobrious language to him; and they put in their *Vchilobi* beams, and the bravest soldiers whom the Spaniards were unable to rescue when they left the city, and who were all put to death. One night the Marquis left the city and went to Tascula, where he was received by its lord, *Xicotenga*.

On the death of *Muteçuma*, the Mexicans chose for their lord *Ouitlavaçi*, lord of *Estapalapa*, a brother of *Muteçuma*, he ruled eighty days, the smallpox[56] broke out throughout all the Indians, and many perished before they returned to subjugate the city.

The Marquis came to *Tezcuco* having conquered all the land in its vicinity, and the people of Chalco made war on it; while he was in Tezcuco, *Guatemuça*, son of *Viçoçi*, was chosen lord, and he made war on Chalco, and without cause he slew six of their chiefs (in the year 199). It took the Marquis eighty days to conquer his way to Mexico. The Marquis made *Istisuchl* lord of Mexico, who in the year 200 died, lord of Tezcuco, and *Juan Velasquez*, deposed him, and reigned eighty days. *Guatemuça* was made lord of *Tatiluleo* (year 201), and presently sent to all the surrounding people to call them to a war against Mexico; and these people came at once and informed *Juan Velasquez* of the matter, and he said it made no odds to him, for he was not its lord. The Marquis left new Spain in peace and went to Honduras (called in Indian *Guaimula*), and left his subordinate deputy, *Peralmildez*, as Captain-General, and returned to Castile. Don *Martin*, son of *Muteçuma* (year 202), and the deputy who were named in place of the Marquis, made requisitions on the Mexicans for gold and silver, and they put to the torture one Rodrigo De Paez, because he would not tell where the Marquis kept his gold and valuables, and finally as he would not give them the information, they hung him (year 203); when the Marquis returned, he seized the factor and overseer, but did not punish them as they had deserved, but sent them back to Spain (year 204). The Marquis made *Tapia*, Governor of Mexico, his Deputy, and in this year 295, *Nuño de Guzman* came to Panuco. The Marquis departed for *Castile*. In the year 206 there were rains of bloody drops, and it was the Sabbath about two o'clock, and everybody saw them, and in this year there appeared an omen in the sky of a white color, and shaped like a lance. In the year 207 *Nuño de Guzman* left for *Neuva Galicia*, and the four councillors of Castile came, *Salmeron*, *Maldonado*, *Çainos* and *Quiroga*;[56] they made Don *Pablo*, Governor.

[NOTE BY H. P., JR.—*Here follows what should have been a chapter by itself, being entirely disconnected from the subject already treated of. The historical part has come to an end, and this seems like an addition by another hand, being somewhat of a repetition of matters previously touched upon.*]

They calculate their year from the March equinox, when the sun casts a direct shadow, and as soon as they can notice that the sun is beginning to rise[57] they count it as the first day, and from the twenty to twenty days, which make their months; they reckon their year, with five days omitted, so their year only comprises 360 days; and from the day which was the

equinox they reckon the day of their feasts, and so the feast of bread, which was the day of the nativity of *Vchilobi* from the plume, was the day when the sun was in declination, and so as to the other festivals.

The Mexican Indians believed that in the first heaven there was a star, *Çitalmene,*[56] which was a woman, and *Tetal Latorras* (*sic*), who was a male, whom *Tenacatecli* (*sic*) made for guardians of the skies, and the woman never is seen because she is on the road that the heavens make.

In the second (*heaven*) they say there are certain women who have no flesh whatever, but are all bones, named *Teçauçigua,*[58] and otherwise called *Çiçimine*; and that these are placed there so that when the world comes to end, their duty will be to eat up all the men.

And when the old people are asked when the end of the world shall come, they say they don't know unless it is when the gods themselves shall all become extinct, and *Tlazquitlepuca* (*sic*) shall carry away the sun, and then all things shall pass away.

In the third (*heaven*) are the 400 men whom *Tescatlapuca* (*sic*) created, and who were of five colors, yellow, black, white, blue and red, so these kept ward in the heavens.[23]

In the fourth were all manner of birds who from thence descended to the earth.

In the fifth were vipers of fire, whom the *Fire-god* had made, and from them issue the comets and omens of the heavens.

In the sixth were all the winds.

The seventh was full of dust which thence came down on earth.

In the eighth all the gods came together, and from there no one could ever ascend higher, to where dwelled *Tenacatli* (*sic*) and his wife; and no one knows what is in the rest of the upper heavens.

Being questioned as to the sun's whereabouts, they replied that he dwelt in the air, and traveled in daytime and not at night, because he returned to the east when he had reached the summit at midday, and that his light then was that which already shone forth towards his setting-place; and that the moon is always traveling after the sun, and never catches up with him.

Being questioned as to the matter of thunder and lightning, they said that the Water-god had many subjects made by him, who carried each one an earthen money-jug[13] and a rod, and that from these earthen vessels they cast down the rain, and that the thunder was when they struck the vessels with their rods, and that the lightning flashed from these vessels.

The people of *Culuacan* say that they came, conjointly with the Mexicans, to Tula, and there they split and went direct to *Culuacan*, and thence to *Suchimilco* and *Malinalco* and *Ocuyla*. These four towns they settled and on the way peopled *Cuitralavaca*, and so 120 years passed away, and afterwards the Mexicans came and arrived at Chapultepec, as has been said, and waged war on the people of Culuacan.

In the histories of Mexico, represented by Indian paintings, are shown many naked Indians, at whose beginning are some clothed in plants,

thereby meaning to convey that when they fled to Mexico they were dressed in that manner, and that they subsisted on what they could obtain by fishing, and that they had to undergo great hardships; and they paint no more valiant warriors. And these were forty years without a lord. The first lord of the Mexicans was named *Acamapichil*, who lived twenty years. In this time it happened that two women misbehaved,[59] the one with the other, and they stoned them to death close to *Escapuçalco*, which is called *Teculuapa;* before this judicial act was performed, the lord of *Escapuçalco* reported it to him of *Guatlinchan*, and the two reported it to the lord of Mexico, and all of them ordered it to be done. And likewise came to pass that *Xilot Iztac*, daughter of *Anil Mixtli*, was married to the brother of the lord of *Ascapuçalco* (*sic*), and when he died his brother, the lord of *Ascapuçalco*, took her for his wife; and she went off to Suchimilco, and did wickedness with Ananacalt, and when it became known to the three lords, they took them and stoned them to death. They say it was the custom that a brother's widow could not lawfully remarry except with a surviving brother, and if she married any one else she forfeited her lands and all her possessions. The first lord of *Ascapuçalco* was named *Teçoçomucli*.

At this very same time it came to pass that two lads stole the grains of maize that had been sowed in the earth, and they were taken and sold for slaves, and the price paid for each one was five mantas.

And in these days it happened that a woman stole certain maize from a granary, and a man saw her and told her that if she would let him lie with her he would not inform on her, and she did so; but afterwards the man accused her of the deed, and the woman confessed all that had taken place, whereupon she was acquitted, and the man was given as a slave to the owner of the maize.

At this time it happened that two lads robbed five ears of maize before it had ripened, and they were ordered to be hung, as it was a greater crime to take them before they were mature than afterwards. And when the first lord of Mexico was dead, the Mexicans remained three years without a ruler, after which they chose *Viçiliutli*, son of their first lord, who lived twenty-five years. In his time it came to pass that a man of Tezcuco kept a watch over his wife, and three days after her confinement he caught her with the sacristan of the temples, and he seized them and the three lords condemned them to death. And it also happened that a man found his wife with another man, slew the man and not the woman, and she came back to live with her husband, for which reason both she and he were put to death.

When the second lord died the Mexicans chose *Chimalpupuca* for their ruler, who lived eleven years. In the days of this third lord it happened in *Chimaloacan* that a woman saw a drunken man and went to him and lay with him, and for this they stoned the woman, but inflicted no punishment whatever upon the man.

And at this time it happened that a man of *Tenayuca* had a granary of

maize, and a man from *Quatitlan* robbed him by an enchantment cast upon it, for he fell into a deep sleep by this contrivance, and the man and his wife took all they found ; and when this was known to the three lords they were both condemned to death, the man and his wife.

He who stole a hen was enslaved, but he who took a dog was not punished, for they said that the dog had teeth wherewith to defend itself.

When the third lord died the Mexicans elected to that power *Iscoaçi*. And at this time the *Escapuçalcans* commenced a war against the Mexicans, and called on the people of Tezcuco and *Tultitlan, Quautitlan, Tenayuca, Tlacuba, Atlacubaya, Cuhuacan, Culiacan, Suchimilco, Cuitlauaca*, and *Misquique ;* all these peoples marched against Mexico, and were vanquished.

Whilst the Mexicans were ruled by lords that part of *Tatilulco*, which now is known as *Santiago*, was likewise under rulers, for whilst *Acamapichtli* and *Vichilituitli* reigned in Mexico, which was for forty years, in Tatilulco ruled *Quaquapuetaque*, the father of the lord of *[illegible]*; this latter was for two years ruler of Mexico before they had a lord in Mexico; he lived forty years. And while there ruled in Mexico *Chimalpopoca* and *Iscoaçi*, there reigned in *Tatilulco*, *Tlacatiuçi*, son of the first, who lived twenty-three years. Whilst *Muteçuma* the elder reigned in Mexico, in *Tatilulco* ruled *Quatlatleaçi*, son of *Tlatesuçi*, and he slew the former, and lived thirty years. Whilst in Mexico ruled *Axayacaçi*, in *Tatilulco* ruled *Moquiuiçin*, brother of the last, and married to the sister of *Axayacaçi*, and on her account there was war between the two because she gave out her husband was a man of war who had conquered the Cotastans and Mexicans, and on that account his neighbors hired his services. Whilst *Teçiçicaçi* ruled in Mexico, in Tatilulco ruled *Ouacoiuçiçi, Tucaxcal Tecli* and *Tlaueloquiçi*, and *Tatilulco*. Whilst *Auçoçi* ruled in Mexico, in Tatilulco reigned *Çiquac Pupucu*, who was the son of *Tacatecal*, and son of *Quatlatoaçij*, and *Yulocoauiçi*. Whilst in Mexico *Muteçuma* then reigned, in Tatilulco there ruled *Tiypantemitçi, Ticoque* and *Aguatel*, grandson of *Muquiniçi* and *Ysciaçi Tacuxcalcotlequinal*, and this one could not[illegible] with *Muteçuma*. While *Muteçuma* and *Juan Velasquez* and *Tapia* were governors of Mexico, he who at first was not a chief personage in the time of the Marquis, *Don Juan*, was governor of *Tatilulco*, the father of him who is governor to-day, and he was a common man and maçegual of Mexico.

They held certain laws in war which they executed in grand style ; and it was the custom that if the captains sent out a messenger and he did not tell the truth he died for that ; and likewise they had another law that any one who should give advice to their adversaries should die for it ; and likewise they slew any man who lay with a captive woman, and likewise he who was captured alive was slain. And if one captured a prisoner alive and another tried to rescue him, it was punished with death. In war-time they had five captains who at the same time were judges. There was a person who hunted up crimes and painted them, and gave the

information to the five lords jointly, and after consultation with the chief lord there were other five who carried into execution what the five had decreed.

There were other laws in their Tianguez or fairs which are as follows: If the son of the lord turned out a gambler and a swindler (*tahur*), and sold his father's possessions or other portion of land, he was secretly choked to death, and if he was a maçegual or fisherman, he was sold into slavery. Likewise, if one stole magueys to the number of twenty to make honey, they should pay as many *mantas* as the judges should ordain, and if the party did not own sufficient or if there were more magueys, he or they became a slave or slaves. Whoever should borrow mantas as a loan, and neglect to repay them, should be a slave. A theft of a fishing net was to be paid for in *mantas*, and if the party did not own them he became a slave. If one stole a canoe or vessel in which people went, he should pay the value of the canoe in *mantas*, and if he had not enough he became a slave. If a man lay with a woman slave who was under age he became a slave also with her, and if she became sick and died, he became a slave, and if she did not die he paid for her cure.

If any one brought a slave to *Escapuçalco*, where there was a slave mart, and the purchaser gave mantas for him, and the seller unfolded them and was content with them, if afterward he rued his bargain he should return the mantas, but the slave became free. If any one did not grow up to natural size, and the relations sold him, and it was known afterwards, when he had come of age, the judges should order as many mantas to be paid as to them seemed fit to give his owner, and the slave became free. If a slave woman fled away and was sold to another person, upon its being discovered, she should return to her master and the price be lost that was paid for her.

If a man lie with a slave, and she dies, being pregnant, he shall become the slave of her master, but if she conceive and bring forth a child, the child is free, and shall belong to its father.[60] If any conspire to sell a freeman for a slave, and the fact become known, all who took part in the affair shall become slaves, and one of them shall be given to the purchaser, and the others be divided between the mother of the person wrongfully enslaved, and the informer who discovered the transaction. Any persons who administer potions with intent to procure death shall be strangled for the same, but if the person murdered was a slave, the murderer shall become the slave of his master. If any one shall steal as much as twenty arribas of maize, he shall die for it, but if less he shall be redeemed by a ransom.

He who steals unripened maize shall be beaten to death with rods. He who steals the *yetecomatl*, a species of gourd fastened with thongs, and worn on the head with tufts of feathers, such as the lords wear, sprinkled with green tobacco, he who steals it shall be garroted to death. He who steals a chalchui, which was a string with certain computations forbidden to be owned by men of low degree, shall be stoned to death in the

Tianguez, wherever he may be. And he who in the Tianguez[41] shall steal anything from the dwellers within the Tianguez, shall be stoned to death. Highway robbers were also to be publicly stoned to death. Any priest who got drunk was to be slain in the house where he became intoxicated, and to be beaten to death with clubs; and the marriageable youth who got drunk was taken to a house known as *tepuxcali*, where he was choked to death; and any person of importance who held public office and got drunk, was deprived of his position, and if he was a warrior they took away from him the title of *valiant man*. If a father lay with his daughter, both were to be strangled to death by a rope passed around both their throats. He who lay with his sister was to be strangled with the garrote, a crime they considered detestable; and if one woman lay with another, they strangled them with the garrote. If a pontiff was found with a woman, they slew him secretly with the garrote or burned him alive, tearing down his house, and forfeiting all his possessions, and all who knew the matter and kept silence about it and concealed it, were likewise put to death. There was no punishment for adulterers unless they were taken *in flagrante delictu*, in which case when caught they were stoned to death publicly.

Chapter th.

Whence originated the Lords of Tochimilco.

The beginning of these lords was one *Yzcocutl* who came from *Tula*, and dwelt in *Atlixco* where they received him for their ruler, and afterwards he left them and settled in *Xuctectitl* and *Vepevcan*, now known as *Tuchomilco*, and there he died. His wife was named *Chimalmaçi*, and likewise she came from *Tula*. On his death his son *Tonaltemitl* succeeded him, whose wife was *Çalpaloci*, a native of Petlauca. On his death *Çintlavilçi* succeeded to his father's power, his wife was *Teyacapançi;* he was a native of *Cuyuacan*, and left sons, who, however, did not inherit his position.

On *Çintlavilçi's* death his two brothers, named *Yxteveyuçi* and *Çivacoaçi* succeeded him in reign, and they held equal powers; their wives were natives ot *Vcpetlavca*. On the death of these two lords they were followed in their seignory by two others, *Cacamaçi* and *Civacoaçi; Cacamaçi* was uncle of *Civacoaçi*, who was the son of *Yxteveyuçi*, and their wives were natives of *Vcpetlavaca*. On the death of these two lords, *Cuapili* succeeded to the throne, and he was a grandson of *Civacoaci*; who was lord before the other two; and *Cuapili*, while still living, made his son, *Mixcoaci*, ruler of a certain portion of the people; the wives of the father and son were from *Petlauca*, and in the days of these came the *Xpianos*.* When these were dead, Don *Miguel* and Don *Juan* succeeded them, of whom Don Miguel was the more powerful; and he came to the seignory, because his uncle was *Cuapili*, and the former came forth in peace to the Christians, while the latter fled away. The Marquis made him lord with the consent of the people. Don *Juan* was his brother *Mixcoaci*, and for

* Meaning Christians ?

this reason succeeded to the seignory; the wife of Don *Miguel* was of *Quizuquechula*, and that of Don *Juan* of *Aupetlavaca*.

Of the Manner in which they Reckon their Months and Days.

It is to be remarked that they consider twenty days as their week or month, counting in both the first and the last as being but one day, as if we should say there were eight days in the week, reckoning Sunday as both first and last. Also they count time from four years to four years, because they do not number their years higher. Also (*a lacuna*, * *)

In these festivals when the sacrifice is offered by the pontiffs,[62] they cover up their heads with certain white mantas on which they arrange white plumes, I mean on their heads, and they robe themselves in a painted shirt open in front, and in this manner they sacrifice.

Appendix.

Annotations and Corrections to the Codex Ramirez.

[1] *Tonacatecli*, called by Brinton (who follows the classical authorities) *Tonacatecutli* and his wife *Tonacacihuatl*. The name *Tonacatecutli* is supposed to signify Lord of our Existence, and *Tonaca Cihuatl* to mean Queen of our Existence. (Vide Am. Hero Myths, p. 73 and note.)

[2] There were two Tezcatlipocas, the red and the black, of whom the myths blended. (Brinton, A. H. M., 73.) The names of these four brothers are differently stated by various authors. *Tezcatlipoca-Camaxtli* was the spirit of darkness (eo. lib., 68). (*The shining mirror.*) Stone seats were placed around the streets for him to repose on, on which no native ever dared to sit. *Clavigero*, 1, 244.

His principal image was *Teotetl* (divine stone), black and shining like marble and richly dressed. He was called by Herrera (III, II, ch. XV) Tezcaltipuiça; by Boturini (p. 11) Tezcatlipoca; by Garcia (IV, 300) Tlezcatipuca; *Titlacauan* was also one of his common names, meaning "we are his slaves." (A. H. M., 106.)

Of the three names, the one given by Boturini is correct. According to Mendoza (Anales de Museo Mexicano), the meaning of the word is brightness, darkness and smoke, being the silver resplendency of the moon illuminating the darkness of the night, breaking through a smoke-like obscurity.

Brinton (Am. Hero Myths, p. 71), leans to the more generally received interpretation of smoky mirror (from Tezcapoctli), meaning the rising of the mist from the surface of the waters. Tezcatlipoca was the god of gods, compared by Garcia to Jupiter, the supreme invisible essence, "the most sublime figure in the Indian Pantheon" (Brinton, lib. cit., 69); also the youth, omnipotent, exacting of prayer, creator and disposer of men; the enemy, the worker and night wind. The divine Providence according to Boturini. See note 7.

[3] *Camaxtli*. Also called Teotlamacàzqui (the hieroglyphic of the priests). Tezcatlipoca-Camaxtli the spirit of darkness. (American Hero Myths, Brinton, ch. 3. p. 68.) Titlacàhuan, we are thy slaves. (Bot. xi.) (Cf. Note 27).

[4] Quatzalcoatl (Bot. 11.) Herrera 3, 3, *xiv*. Quetzalcoatl (Brinton A. H. M.), passim. Quetzalcohuatl (Bot. 25) hieroglyphic of the Air. Quetzalcoatl (Garcia, IV, VII, 262), was a "white man with a beard, of industry and intelligence, who fled from the tyranny of Huemac (*the great hand*), King of Tula, and took refuge at Cholulla. He is the spirit of light and culture, ever engaged in a continual warfare with his brother, Tazcatlipoca, the spirit of darkness. (A. H. M.)

Quetzalcoatl (Clavigero, 1, 246), "feathered serpent," god of the air.

Vetancourt (Clav. 1, 250). *Coatl*, a twin, *Quetzalli*, a gem.

Queçalcoatl, por otro nombre yagnaliecatl. The name was applied to him in his relation to the winds, whose ruler he was, the words *Yahualli ecatl*, meaning "the Wheel of the Winds." *Yahualli* is from the root *yaual* or *youal*, circular or round, and the towers where he was worshiped were of this form. (A. H. M., 121.)

[5] *Om tectli.* Qy. Ometochtli (two rabbits), the god of wine.

Omitecutl. Clavigero I, 245.

Ometeuctli and omicihuatl, god and goddess residing in heaven, propitious to mortals. Also known as *Citlallatonac* and *Citlalicue*.

[6] *Moyocoya*, or more properly *moyocoyatzin*, is the third person singular of the verb yocoya, to do, with the respectful or reverential termination tzin (A. H. M., 70), meaning "he who acts or does." Ramirez translates it as "the omnipotent" (*todo poderoso*); Brinton, the determined doer. The title is given him in reference to his demiurgic power.

[7] Evidently an error for the terrible war-god, Huitzilopochtli. (Boturini 27; Herrera III, III, 17, *Vitzilipuztli*. Lorenzana, I. Huitzilo-potzil.)

In the sixteenth century it was customary to express the same sound indiscriminately by *Vi* and *Hui*. (Orozco y Berra. Anales II, I, 71.)

Garcia (IV, 300) Huitzilopuctli answers to Mars. In this author the name occurs most frequently as Vitzilipuctli.

Vchilobos. Clavigero (Cullen I, 251). Huitzilin, a humming bird. *Opochtli*, left. Boturini wrong. The Spaniards, unable to pronounce the name, usually called him Huichilobos. Orozco y Berra (Anales II, I, p. 71), thinks that of all the forms *Vitziliutl* is the most correct.

[8] (Çipactonal, Boturini 46, the father superior to the son.) Çipastonal and Uxumuco, more properly *Çipactonal* and *Oxomuco*. (Oxomòzco, *Boturini*, p. 46), whose names have not been as yet satisfactorily explained. "*Tonal* is no doubt from *tena* to shine, and *cipactli* * * * from *chipauac*, beautiful or clear. (A. H. M., 74. Vide Chavero, Anales, II, 116.)

[9] Maize. Maize was the emblem of *Centeotl*, goddess of cereals, who was the same as *Xilomen* (from *Xilotl*, a young grain of maize). She was also the same as *Tzazolteotl*, the Venus vaga, goddess of impure love. L'Ecriture hieratique Maya par Leon de Rosny, p. 185.

[10] Tlalocatecli. *Tlaloc* was, according to Boturini (p. 72), the second deity and quasi minister of the Divine Providence. Brinton (A. H. M., 75, 123) considers him as the god of darkness; his name being, according to some, wine of the earth. Tlal (*tlalli*, earth) oc (*ocqui*), wine of the maguey plant; according to others, dweller on earth, *tlalli* (the earth) and *onac* (being).

The name according to Brinton (A. H. M., 123) should be Tlaloctecutli, lord of the wine of the earth.

Garcia (IV, II, 139, ch. vii) Tlalocatecutli is the god of water; Tlaloc (IV, VIII, II, 143).

Clavigero I, 251. Tlaloc, god of water; he resided on the highest mountains where the clouds are formed

[11] Chalchiuhcueitl (Boturini 25). La della Saya de Piedras preciosas, hieroglyphic of water; is generally shown with reeds. Probably took her origin among canebrakes. Cf. Venus sprung from the Sea.

Chalchiuitlicue, Chalchihuitlicue, Brinton, (A. H. M., 123, p. 75). From Chalchiuitl, jade. Cueitl, skirt, petticoat. Cf. *Kilt*.

If Tlaloc was the god of water and tropical rains, may not his wife have signified the verdant results from his beneficial showers.

Chalchihuitlicue. Clavigero (tr. Cullen I, 240), goddess of water, 252. The high priest wore the same habit in which they represented her as the goddess of water. Cf. p. 252, for names given by Torquemada and Boturini.

Chalchihuitlique was the goddess of water and companion of Tlaloc. Torquemada calls her *Xochiquetzal*, and Boturini, *Macuixochiquezalli* (Clavigero I, 252). According to the Codex *Telleriano-Remensis, Chalchiutli* saved herself from the

deluge. Her name signifies "The woman adorned with a dress of precious stones. According to Sahagun she was the sister of the Tlalocs, the rain gods (Codex Troano, 102).

Chalchiuhtlenh, *a modo de Esmeralda.* Sandoval, Gram. Mex., 53.

[12] *Alcançia*, literally, a money-jug of earthenware.

[13] *Hunchback.* It was the custom among the Aztec lords to have among their attendants for their diversion hunchbacks, just as the Mediæval barons had in their train their fools and jesters. The sacred cavern was that of *Cincalco.*

Quetzalcoatl was followed in his passage of the Sierra Nevada by hunchbacks, who mostly froze to death (A. H. M., 115). These formed part of the suite of the last Montezuma. They were interred with their Caciques. (Herrera ii, 165.) *Chalco*, seems to be derived from *Challi*, an emerald. Buschman, 689.

[14] Called Çipagli in preceding part of the chapter.

Çipactli (A. H. M., 74, 126). the great fish. Cf. the fish *Oannes* in the Chaldæan mythology, *Dagon* of the Philistines and Phœnicians, *Pisces* of the Syrian and Egyptian Zodiac; supposed to be sun myths, the sun rising out of the East.

Cipoconal and Oxomuco, the first created pair, qy. *pisces* of the Zodiac, &c. Note 9. Chavero (Anales I, VII, 245) considers Cipactli the first light below the horizon.

Jesus is represented as a fish, because the Messiah in the Talmud is called *Dug*, *i. e.*, the fish. King's Gnostic's and their remains, 138.

[15] Tlaltecli, the earth, from tlalli, the earth.

[16] The wife of this son was made of the hairs of the divine mother of the four brethren—gods, whose name was Xochiquetzal (Beautiful rose). (A. H. M., 73, 74.)

[17] Garcia (*Origin de los Indios*, V, IV, 327), gives a different account of the creation of which the following is a résumé:

"At the distance of a league and a half from *Guaxaca*, in an Indian settlement named *Cuilapa*, there is a convent of my order whose Vicar, at the time of my coming there, owned a MSS. volume, * * * written in the figures used by the Mexicans, and with the explanations thereof, setting forth the origin and creation of the world, and the deluge, &c. This book I tried by all manner of means to obtain, but the holy father set too great a store on it to part with it, but permitted me to make such extracts from it as I desired.

"In the year and in the day of darkness and clouds, before there were any days or years, the world was plunged into total obscurity, and all was chaos and confusion; the earth was covered with the waters, and there was nothing but mud and débris over the face of the globe. In these days there appeared visible to sight a god whose name was the stag (*Ciervo*), and whose surname was Lion-viper (*Culebra de lion*), and a very charming and beautiful goddess, whose name was likewise *Ciervo*, and whose surname was Tiger viper (*Culebra de tigre*). From these divinities originated all the other gods of the Indians. As soon as these two gods appeared they took on human shape, and being omnipotent and omniscient, they founded a huge rock (*Peña*), on which they built sumptuous palaces, made with the greatest art, where was their home, and their abode on earth; and on the summit of the most lofty part of the palaces, there stood an axe of copper with its edge upwards, upon which the heavens rested. This rock and the palaces of the gods were on a very lofty mountain peak (*Cerro*) near the pueblo of Apoala, in the Province known as *Mixteca Alta*. This rock, in the language of that people, bore for its name *The-place-where-the-heaven-was*, by which they meant to express that it was the Paradise and abode of all manner of pleasure and happiness, and where there was an abundance of everything that was good, and where not the slightest element was ever lacking to complete felicity. This place was where the gods abode at their first coming on earth, where they remained many ages in quiet and contented rest, as the locality was so pleasant and charming, but the world was all in darkness and clouds. * * * Of these gods, the father and mother of

all the other divinities, in their palaces and court, were born two sons, very beautiful, shrewd and learned in all the arts and sciences. The first was called *The-wind-of-the-nine-vipers*, which he took from the name of the day on which he was born; the second received the appellation of the *Wind-of-the-nine-caverns*, that being likewise the name of the day on which his nativity occurred. These two youths were brought up in great pomp. The elder when he would amuse himself, took the form of an eagle and went flying through the highest skies, the second transformed himself into a tiny animal in the form of a winged snake, with which he flew through the air with so great a velocity and subtlety that he penetrated the hardest rocks, and became invisible. The effect of which was that those who were over his head could hear the noise and turmoil that was made below. The meaning of these figures was to exhibit the power that these gods possessed of transforming themselves and of their returning to their own shapes.

"These brothers then remained in their paternal home, living in comfort and peace; they bethought themselves that they would make an offering and sacrifice to the gods, their parents, to effect which they took censers of clay with burning embers upon which they cast a certain quantity of ground poison in lieu of incense. This, say the Indians, was the first offering ever made in the world. After they had made this oblation, the brothers created a pleasure garden for their recreation, in which they placed trees and flowers, fruits and roses, sweet-smelling plants and other varieties of vegetation. Here in this garden and orchard, they refreshed and recreated themselves all the time and they made near it another pleasure-ground (*Prado*), in which were stored all manner of things necessary for the oblations and sacrifices which they had to make and offer to the gods, their parents.

"Whenever these brothers left the house of their parents, they disported themselves in this garden, taking care of the trees and plants, and seeing to their increase and preservation, and offering from time to time the aforesaid oblation of poison, &c. They prayed to their parents at the same time, making vows and promises, and supplicating them by virtue of the oblation which they were offering, and through the other sacrifices they gave them, that they would think well of creating a heaven, and that they should shed a light upon the world, that they should create the earth, or rather let the waters sink and the dry ground appear, for that they had no other abode and resting place than the narrow limits of their garden and orchard. And still more to force the gods to accede to their request, the suppliants pierced their ears with lancets of flint, drawing blood from them in torrents. This they did also to their tongues, and with the blood they sprinkled the branches and trunks of the trees by means of a sprinkler made of the branches of the willow tree as a thing holy and blessed. This action they performed to show their entire submission to the will of their parents whom they regarded as being greater gods than themselves. * * * These gods had children * * * after which there was a general deluge in which many of the gods were drowned. When this had ceased, the creation of the heavens and the earth was begun by a god whom they name *Creator of all things*, who restored the human race, from which was populated the *Mixtec* kingdom."

[18] OF THE MEXICAN YEAR.

Boturini 2.		*Gemelli* (Anales I, 7, 299).
1 Tecpatl,	(pebble)	1 Calli
2 Acatl,	(reed)	2 Acatl
3 Tochtli,	(rabbit)	3 Tecpatl
4 Calli,	(house)	4 Tochtli

Veytia agrees with Boturini, and Orozco y Berra (Anales I, 7, 299), accepts their arrangement and nomenclature.

The eighteen months of the year are named as follows:

Names of the Months.

(Lorenzana, 2.)		Orozco y Berra (Anales I, VII, 291).
1. Atemoztli	(water month)	1. Itzcalli, Xochilhuitl.
2. Tititl	(things even and just)	2. Xilomanalzitli, atlacahualco, Cuahuitlehua, Cihuailhuitl.
3. Yzcalli	(new creation)	3. Tlacaxipehnaliztli, cohuailhuitl.
4. Xilomanizte	(offerings of the new maize)	4. Tozoztontli.
5. Coanilhuitl	(grand festival of the viper)	5. Hueytozoztli.
6. Tozcotzintli	(lesser fast)	6. Toxcatl,Tepepochuiliztli.
7. Huey Tozcoztli	(greater fast)	7. Etzalcua liztli.
8. Toxcatl	(dangerous for the fields)	8. Tecuil Nuitzintli.
9. Ezalqualliztle	(eating of dry fruits)	9. Huey tecnilhuatl.
10. Tecuilhuitzintli	(feast of the youthful cavaliers)	10. Micailhuitzuitli, Tlarochimaco.
11. Huey Tecuithuitl	(feast of elder lords)	11. Huey micail huitl, Xocotlhuetzi.
12. Micta ilhutzintlil	(lesser feast of the dead)	12. O.·hpaniztli, Tenahuatiliztli.
13. Huey mictail huit	(greater feast of the dead)	13. Pachtli, Teotleco.
14. Ochpanitzli	(broom)	14. Hueypachtli,Tepeilhuitl.
15. Pachtlizintli	(early grains)	15. Quecholli.
16. Hueypachtli	(grains and large trees)	16. Panquetzaliztli.
17. Quecholli	(the flamingo?)	17. Atemoztli.
18. Panquetzallitzli	(pennons or banners)	18. Tititl.

Days of the Months.

Lorenzana (2)	Chavero (Anales I, VII, 245).
Cipactli (serpent)	1. Cipactli (the first light from below the horizon)
Ehecatl (air)	2. Ehecatl (the wind)
Calli (house)	3. Calli
Cueztpallin (lizard)	4. Cuetzpalin
Cohuatl (viper)	5. Cohuatl
Miquitzli (death)	6. Miquitzli
Mazatl (deer)	7. Mazatl
Tochtli (rabbit)	8. Tochtli
Atl (water)	9. Atl
Ytzcuintli (a common dog)	10. Itzcuintli
Ozmatli (a she ape)	11. Ozomatli
Malinalli (a mesh of cords)	12. Malinalli
Acatl (reed)	13. 1. Acatl
Then follows the second group:	
Ocelotl (tiger)	14. 2. Ocelotl
Quaotli (eagle)	15. 3. Cuauhtli
Temtlatl (grindstone)	16. 4. Cozcacuauhtli
Quiahuitl (rainy water)	17. 5. Ollin.
Xochitl (flower)	18. 6. Tecpatl
	19 7. Quiahuitl
	20. 8. Xochitl

[19] *Cintrococopi*, qy. from *cintli*, spindles (Mazorcas), full of dry and cured maize and *cocopatic*, something that burns the mouth greatly. (*Molina* sub vocibus.)

[20] The story of the falling down of the heavens appears among ... Samoa, where two trees are reported to have grown up and pushed them into proper place. The natives of *Vaitupu* have a tradition in which two of the sons of the first couple "distinguished themselves by raising the heaven higher." In *Nikundu*, the legend runs of an universal darkness in the beginning of all things and that the heavens were down and resting upon the earth until raised by two brothers. (Samoa, by George Turner, pp. 198, 288, 291.)

[21] The two trees into which the gods changed themselves; more properly, Tezcaquahuitl, the tree of the warrior. Quetzalveixochitl, the beautiful rose tree. —A. H. M., 75.

[22] Mixcoatl, a name of Tezcatlipoca. Brinton, A. H. M., 84. Istac Mixcoatl (A. H. M. 92), white-cloud, twin.

[23] Four hundred men created. Brinton considers them to be the stars, especially as they later were translated to the sky. Codex Chimalpopoca (Myths, New World, 207). Four birds devoured the antediluvian dwellers on earth.

[24] They drew blood from their ears, &c. In ch. 8 (seq.) Camaxtli takes a maguey thorn and draws blood from his tongue and ears. The Persians drew blood from ears, arms and face. Cf. *Garcia*, iv, 301.

[25] *Talocatecli* threw his son into the cinders. Should be *Tlaloc*. (Cf. Abraham and Isaac.)

[26] Chichimecas (Garcia, V, 2, 322), offered no let or hindrance to the immigrants who drove them away, but were filled with fright and astonishment, and hid themselves among the most inaccessible rocks.

But the C. on the other side of the Sierra Nevada, where the Tlascaltecans came, did not behave in this manner, but valiantly resisted the invaders, being of gigantic stature, endeavored to drive them out of the land, but were ultimately overcome by the force of the Tlascaltecans. Then they had resort to stratagem, and feigning peace and submission invited their conquerors to a banquet at which concealed men precipitated themselves upon the Tlascaltecans when they had become drunken and helpless. However, the Tlascaltecans rallied to the assistance of their comrades, and being better armed and disciplined, ultimately defeated the giants, leaving not one man alive. After many generations the barbarous Chichimecas became civilized, wore clothes and became as other people, forming themselves a state. (Cf. Garcia, V, 302.)

Chichimeca. (Clavigero tr. Cullen, I, 91), according to some from *Techichiani*, sucking, because they sucked the blood of the animals which they hunted. C. calls them *Chechemecatl*, (Betancourt), from Chichimi, dogs' beans. If the name had been one of contempt they would not have prided themselves upon it, as they did. Another point to show it was an indigenous word.

A number of conjectural etymologies have been assigned for this name, but all unsatisfactory. As this people appear to have been aboriginal it seems to me that any attempt to explain its name by means of the language of the conquerors must be futile. Those who speak an alien tongue have always been looked upon by their neighbors as barbarians, and even as not possessed of rational speech, but as using only an unintelligible jargon. The Latin dramatist expresses the feeling in his lines, *Barbarus hic ego, quid non intelligor nulli.*

According to Garcia (V, 3, 321), the word Nahuatl means the people that speaks distinctly and makes itself understood (Cf. Sahagun X, 29.) (Buschman, 685), "well sounding, clear, distinct."

Boturini, 78. Chichimècatl, el que' chupa, from their sucking the blood of animals. *Chichi* means mamar, to nurse. Anales 3, 2, 60.

[27] *Camasale*, more properly, *Camaxtli*, qu., a name of Tezcatlipoca (A. H. M., 90); *la faja noturna* (Anales 3, 363). He was worshiped by the Tlascallans, being there the same as Huitzilopochtli. Clavigero I, 2, 111. (Cf. Note 3.)

[28] Ce acatl, *one reed*, the day of Quetzalcoatl's birth, and by which he was often called. It was a day of evil omen, and no one born on it could hope for success.

This year which returns but once in the Mexican cycle of fifty-two years, was

the one in which the god Quetzalcoatl was expected to reappear; and it
pened that in this very year Cortez entered the land of Mexico. C
prophecies had preceded his advent, and he met a sovereign predisposed
mission.

[29] Tlapalla. This is the *Tlapallan* which Brinton (A. H. M., 89) believe
the "City of the Sun," the original home of the Aztecs. All this he cons
sun myth. The word signifies "the red land" (Codex Mendoza, Anales I,
It was to this country that Quetzalcoatl was to take his journey (Buschm
684).

"*Tlapallan*, the red land, and *Tizapan*, the white land, were really the
for the land of the sun. Tizapan from *tizatl*, white earth, and *pan* in."
Hero Myths, 135.) The idea holds ground among some scholars that th
record is only one of journeyings up and down through the valley of Me

[30] Chapultepeque. Monte des Conejos. (Garcia, IV, 233.) Cerro del Ch
(Bot, 79) ... this bent or curved mounta
... and remain

ERRATUM.

On page 648, 12th line from bottom, for *quid non intelliger* read *quia non intelliger*

the goa...

A similar myth is narrated ...
feathered serpent," which seems more probable from the ...
name with the bunch of feathers, the virgin is stated here to have place
bosom.

[42] *Cuzco* means (Garcia, IV, 233) the navel of the earth.

[43] *Bridge* of Chapultepeque: this is probably a clerical error of *puente* fo
as in the preceding chapter a (fountain or) stream of water (fuente) is sp
as existing at that place. The word means hill of the locust, from c
locust, and *tepec*, a hill. (Cf. Note 30.)

[44] In the original *tes*, meaning evidently *tres*.

[45] In the original *dos*, probably an error for *los*.

[46] Çiquacoatl, more properly Cihuacoatl; the serpent woman (Myt
World, 120); Cihuacohuatl (Clavigero, I, 246).

the one in which the god Quetzalcoatl was expected to reappear; and it so happened that in this very year Cortez entered the land of Mexico. Gloomy prophecies had preceded his advent, and he met a sovereign predisposed to submission.

[29] Tlapalla. This is the *Tlapallan* which Brinton (A. H. M., 89) believes to be the "City of the Sun," the original home of the Aztecs. All this he considers a sun myth. The word signifies "the red land" (Codez Mendoza, Anales I, 4, 173). It was to this country that Quetzalcoatl was to take his journey (Buschman, p. 684).

"*Tlapallan*, the red land, and *Tizapan*, the white land, were really the names for the land of the sun. Tizapan from *tizatl*, white earth, and *pan* in." (Am. Hero Myths, 135.) The idea holds ground among some scholars that this long record is only one of journeyings up and down through the valley of Mexico.

[30] Chapultepeque. Monte des Conejos. (Garcia, IV, 248.) Cerro del Chapulin (Bot. 78). See note 48.

[31] Culuacan. Colhuacan (A. H. M., 92). The bent or curved mountain, the home of the mother of the gods; on it the old become young and remain at any age they desire; years leave no trace upon them. In the legends of the Choctaws occurs mention of a *bending hill* (Myths New World, 225). Duran (I, 1) considers it another name for Aztlan. Cf. Buschman, 691.

[32] *Azclan*, regio de garças, land of the heron. (Garcia, 4, 293) Bright or white land. (Brinton A. H. M., 92. Buschman, 612.) The latter the more generally received; cf. *Tlapallan*, Note 29.

[33] *Suchimilco*, first people (gente de sementeras de Flores), occupied the banks of the great lagoon of Mexico and founded a city of the same name. Garcia, V, § 2, 322.

[34] *Xochimilco*. Place of the field of flowers. (Buschmann, p. 700; Clavigero, 2, 228; Boturini, 78.) Sometimes written *Suchimilco*.

[35] *Mixcoatl* (Brinton A. H. M., 92. Iztac-Mixcoatl, the white cloud twin), goddess of hunting, *Clav.*, i. 126. Same as Camasale (Notes 3, 27).

[36] *Chalcas*. The name signifies *Gente de las Bocas*. Garcia, V, 2, 322.

[37] *Tenpaneca* (*Garcia*, V, 2, 322). Gente de la puente, settled on the west side of the lagoon. They soon founded a large city, Azcapuzalco (Hormiguero).

[38] *Tezcuco*. Garcia (V, 2, 322) says the Tezcucans were the fourth population of Mexico, coming from *Culua* (*Gente corva*), because in their country there was a very crooked *Cerro*.

These four nations encircled the lagoon, and of them all, the Tezcucans were considered as the most polished.

[38] Quausticaca? *lugar de los Pinos*.

[39] Chicomuxtoque, more properly should be *Chicomoztoc*, the Seven caverns. (GARCIA, V, 325: BOTURINI, 78. BUSCHMANN, über die Aztek. Ortsnamen, 683.)

[40] Coatebeque, more properly *Coatepec*, the hill of serpents.

[41] *Quatlique*, more properly *Coatlicue*, "one of the serpent skirt" (A.H. M., 77) from whom Huitsilopochtli was born. According to Clavigero (1257), she was the goddess of flowers.

A similar myth is narrated (A. H. M., 90) of the birth of Quetzalcoatl, "the feathered serpent," which seems more probable from the connection of this name with the bunch of feathers, the virgin is stated here to have placed in her bosom.

[42] *Cuzco* means (Garcia, IV, 203) the navel of the earth.

[43] *Bridge* of Chapultepeque: this is probably a clerical error of *puente* for *fuente*, as in the preceding chapter a (fountain or) stream of water (fuente) is spoken of as existing at that place. The word means hill of the locust, from *chapulin*, locust, and *tepec*, a hill. (Cf. Note 30.)

[44] In the original *tes*, meaning evidently *tres*.

[45] In the original *dos*, probably an error for *los*.

[46] Çiquacoatl, more properly Cihuacoatl; the serpent woman (Myths New World, 120); Cihuacohuatl (Clavigero, I, 216).

[47] Tiçapan } the same place. (Garcia, 326, *Tizaayán*, aguas blancas, white
Tiçapaa } water). The general view entertained by scholars is that the word means the white land (A. H. M., 185), and is the same as Tlapallan, the home in the distant sun. See note 29.

[47*] Here there is something omitted, probably the words "a woman," as the rest of the sentence requires it.

Clavigero (Book II, § 21, Cullen, p. 124, tells a horrible story of a woman's sacrifice (too long to copy), which may be the one here referred to.

[48] Quanmixtitlan, *postea* Tenustitan. Garcia, 325; Cuidad del popul, Bot., 78. Tenoxtitlan, more correctly Tenochtitlan, from *tell*, a stone, and *Nochtli*, a nopal (meaning the wild fig on the rock. *Tunal en piedra*, Garcia, V, 326). Buschmann, p. 702.

[49] Acamapictli. Garcia, V, § 3, 334. Third king of the Mexicans, *Coringio*, being second, and *Tenuch* first. (*Clavigero*, I, III, 127; Lorenzana, p. 9.)

Names of the kings of Tenochtitlan according to

Clavigero, I, III, 127.	*Lorenzana*, 9.
1. Acamapitzin	1. Acamapixtli
2. Huitzilihuitl	2. Huitztlihuli
3. Chimalpopoca	3. Chimalpopoca
4. Itzcoatl	4. Ixcoatl
5. Monteuczoma or Montezuma	5. Montezuma, the elder
6. Axajacatl	6. Tisotzin
7. Tizoc	7. Axalacac
8. Ahuitzotl	8. Ahuitzol
9. Montezuma	9. Montezuma

Anales II, 1, 53.

1. Tenuch, A.D. 1324.
2. Acampichi, A.D. 1370.
3. Huicilyhuitl, A.D. 1396.
4. Chimalpupuca, A.D. 1417.
5. Ixcoaci, A.D. 1427.
6. Huehue moteeçuma, A.D. 1440.
7. Axayacaci, A.D. 1469.
8. Tiçocicatzi, A.D. 1482.
9. Ahuiçocin, A.D. 1486.
10. Moteeçuma, A.D. 1502.

Garcia (v, *iii*, 324), makes Acamapictli the third ruler.

[50] Seems to resemble the title of Prince Consort.

[51] *Cuernavaca*. Garcia (Origin de los Indios, Lib.V, § II, p. 322) says that *Quauhnahuac* (a word meaning the place whence the voice of the eagle sounds) was corrupted in common language into *Cuernavaca*. He states that it was the capital city of a fertile and populous province, which, in his days, was known.

[52] They took away. (Qy. the original one?)

[52*] Tlascaltecas (gente de pan). Garcia, V, 1, 322. Were the sixth people; built and settled, and their chief city was named Tlascala. This nation aided the Spaniards.

[53] Dende un año *ynvernan?*

[54] The Indian woman, *Marina*, who fell in love with *Cortez*, and accompanied him as his interpreter. The words in the original are, "Por una lengua dicha *Marina*."

[55] Sahagun, Lib. XII, ch. 29, also speaks of this epidemic of small-pox.

[56] *Oydores*, auditors, councillors of state.

[57] *I.e.*, the days to lengthen.

[58] Tçauçigua (fleshless women), alias Çiçemine. More properly, Tzitzimimine (Anales II, i, 7), the dreadful ones. The conclusion of a cycle was a grave event for the Mexicans, for, according to their religious ideas, it was possibly the date for the end of the world. "All the inhabitants," says Torquemada, "were in great fear and trembling lest when the lights were extinguished they should never more be rekindled, but on that very night the human race would come to an end, and darkness eternal would reign over all; no sun should ever appear again, but the *Tzitzimimes*, fearful demons, would descend and eat up all mankind." *Anales, &c*, II, i, 7.

[59] 1. *Se echaron una con otra.*

[59*] Quey, ver, omitted? In which case the sentence read *Este no pudo (ver), à Montezuma*, could not bear with Montezuma, detested him.

[60] How much more humane than the maxim of the civil law, *partus sequitur ventrem!* One who lay with an immature girl, or another's slave, became a slave. (Garcia, 8, 2, 111 : Torquemada, XII, 8; Herrera, IV, 8, 10)

[61*] Tianguez should be more properly Tianquitzli. (Anales III. 2, 66.)

[62] *Pap*. "The Mexicans called in their tongue the Supreme Pontiffs by the name of *Papa*." (Herrera III, II, *xv*, p. 690. *Similiter*, Garcia V, XII, 300.)

Papachtic. "He of the flowing locks," corrupted to Papa, was one of the names of Quetzalcoatl (A. H. M., 60), hence the title may easily have been transferred to his priests.

The Pennsylvania Prison System. By Richard Vaux.

(Read before the American Philosophical Society, June 20, 1884.)

The Pennsylvania Prison System had its origin in an effort to correct the abuses in the place of incarceration of all classes of violators of law. The common jail, under the colonial government of the Province of Pennsylvania, was the receptacle of every such offender.

In the city prison of Philadelphia, located at Market and Third streets, in 1770, young and old, black and white, men and women, boys and girls were congregated indiscriminately in custody, for misconduct, misdemeanor, and felony, either before trial, after conviction, or for want of bail for surety of the peace. It was a moral pest-house. Bad as it was, it was better than Newgate, for England was without a rival in the infamous management of her then chief public prison in London.

So early as 1775 a sensible, thoughtful man—a merchant—Mr. Richard Wistar, residing near by, had his attention directed to the horrible condition of this city prison. In 1776, on the 7th of February, a society was formed, styled the "Philadelphia Society for Assisting Distressed Prisoners." The occupation of Philadelphia by the British army terminated the labors of this society in the month of September, 1777. In the year 1787, May 8th, the first society was revived by its successor "The Philadelphia Society for Alleviating the Misery of Public Prisons." Some of the members of the first Society, and others like-minded, engaged in this revival of the organization of 1776.

On the 16th of August, 1787, William White, D.D., Bishop of the Prot-

estant Episcopal Church, as president of this society, addressed the citizens of Philadelphia for aid—aid for a practical benevolence which found the evil, and undertook to apply the remedy. It was not humanitarianism—that restless agitation of the sympathies of try-to do-something people, which usually is converted into mist.

The criminal laws from 1718 to 1794 were ameliorated. In 1718 ten crimes were capital. On the 15th of September, 1786, by the influence of an already developed interest, an act of Assembly was passed to markedly modify the criminal code of the province. This was the first legislative reform. It substituted for robbery, burglary, and the crimes against nature, imprisonment at hard labor, for the death penalty. On the 27th of March, 1789, this first act was amended. The act of April 5th, 1790, repealed both acts, and the act of 1794 made murder only, a capital crime. No important legislation, as to the criminal code, occurred from 1821 to 1860.

The first Constitution of the State in 1776, chapter 2, section 28, provided "That punishments be made in some cases less sanguinary;" and by section 39, hard labor in prisons be substituted. In 1786 some of these provisions were enforced. "Penn's Great Law" of 1682, enacted for his province, 10th section, provided that "all prisons shall be workshops for felons, vagrants, and loose and idle persons." Prior to the Revolution these laws were generally disregarded.

From Mr. Richard Wistar's first efforts in 1775, till April 5th, 1794, slow but effective measures were taken to reform the penal laws and the prison system of Pennsylvania. They were the outcome of the earliest practical thoughts on this subject in America.

It is to be noticed that in Italy, 1718, the Hospital of St. Michael was founded, and there was first introduced in Europe reforms in prison discipline. It was an experiment suggested by philosophy and benevolence, and remained for nearly a century the only like instance on that continent.

It was a successful undertaking. Parenthetically it may be said, without too broad an assertion that, so far as is known, the present congregate prisons of the United States in some features are copies of the St. Michael, originated one hundred and sixty-six years ago.

In 1718, February 22d, a law was passed for erecting houses of correction and work-houses in the Province of Pennsylvania. While this law of 1718 authorized these establishments, they were intended simply as receptacles for vagrants and incapables.

In 1775 a work appeared on "The State of Prisons in England and Wales," which first directed the attention of the English people to the subject of the then terrible condition of these institutions.

During this progress of a thoughtful investigation into the needed reform of existing methods of prison management, it became apparent to those in Philadelphia engaged in the examination, that a radical change in both the crime code, and the punishment of convicts was the only possible relief for the abuses and miseries existing in the prisons. The crime code was

severe without discrimination, the prison treatment of convicts was irrational, disgraceful, and produced those results both were intended to prevent.

The evil was at the root of convict treatment, at the foundation on which the plan rested. Incarceration at hard labor was the only specific for all felonies or crimes of aggravation.

The public mind considered public safety secured if violators of law were imprisoned, and there it ceased to regard the crime or the criminal.

This actual condition of the law and its administration convinced the able men interesting themselves in the question, that in the incarceration of criminals a thorough change of method must be established by law.

The associating or congregating convicts at work or otherwise while in prison was deemed so unwise, degrading, and irrational, if any benefit to the prisoner or advantage to society was expected from imprisonment, that this form of treatment must primarily be abolished. This was the initial step in prison reform. The leading minds investigating this subject reached this conclusion so early as 1787.

A memorial from the Society for Alleviating the Miseries of Public Prisons was addressed to the representatives of the freemen of the Commonwealth of Pennsylvania in General Assembly met, on the shocking treatment of prisoners then existing, in which it is stated "that punishment by more private or even solitary labor would more successfully tend to redeem the unhappy objects." The memorialist recommended for the consideration of the General Assembly "the very great importance of a separation of the sexes in public prisons." Legislation to this end was asked. In this memorial is to be found the first suggestion of two principles, which either in their assertion or presentation, gave no promise of the signal importance they were to exercise over the subject of prison reform, or that they were to become the basis of the Pennsylvania prison system. They were the origin of the system of separation of prisoners during their incarceration, and that labor was an element in their punishment.

To this memorial the Supreme Executive Council of Pennsylvania, on the 20th of November, 1788, replied by the adoption of a resolution asking information as to its subject-matter.

The society made a full statement to this resolution of inquiry, and it was presented to the Council in 1788.

In the following year the society presented a plan for the positive improvement of the prison discipline of the State.

The propositions contained in this plan were enacted into the law of 1790.

In 1773 the erection of a State prison was begun, located at the southeast corner of Sixth and Walnut streets, in Philadelphia, and on its completion the test was applied of the reforms suggested.

The Legislature, by the act of April 8th, 1790, to reform the penal laws of this State and try the separate confinement principle of imprisonment, declared its purpose in this act as follows: * * *

"And whereas, the laws heretofore made for the purpose of carrying the said provisions of the Constitution into effect have in some degree failed of success, from the exposure of the offenders employed at hard labor to public view, and from the communication with each other not being sufficiently restrained within the places of confinement; and it is hoped that the addition of unremitted solitude to laborious employment, as far as it can be effected, will contribute as much to reform as to deter.

"Section 8 of the act provides for the erection of cells in the gaol yard for the purpose of confining there the more hardened and atrocious offenders. Section 10 declares the cells to be a part of the gaol and requires all persons who cannot be accommodated in the cells to be kept separate and apart from each other, as much as the convenience of the building will admit.

"Section 18 restricts the visitors to the prison to various officials and persons having a written 'license' signed by two inspectors."

This law was a decided triumph for those engaged in prison reforms. It was the first authoritative endorsement by the Legislature of Pennsylvania of the two principles to which attention has been called. Though tentative in its object, it placed the Pennsylvania prison system on its trial, limited as it was to the most ill-devised and circumscribed opportunities.

In the year 1801 the society again addressed the Legislature stating the progress made by former Legislatures in preventing crime and reforming criminals were satisfactory, * * * "though it was not expected that the practical part could be suddenly or completely effected." It was considered then only as an experiment. The society again urged the Legislature to make a fair experiment of solitude and labor on convicts.

In 1803 a marked confidence is shown by the memorial of the society to the Legislature, as the following extract proves:

"Placed as we are in a situation to observe the salutary effects of solitude and labor in preventing crimes and reforming criminals, we trust you will as heretofore receive our application with indulgence, and therefore again respectfully submit to your consideration the propriety of granting another building for the purpose of making such separation amongst prisoners as the nature and wants of this truly benevolent system requires."

Persistent in its efforts, and gaining knowledge and faith from experience, in 1818 the society more broadly expressed itself in a memorial to the Legislature. Confirming the satisfaction which thus far had attended the trial of the system, imperfect as it was, the memorialist * * "therefore respectfully request the Legislature to consider the propriety and expediency of erecting penitentiaries in suitable parts of the State for the more effectual employment and separation of prisoners, and of proving the efficacy of solitude on the morals of those unhappy objects."

After such earnest appeals, asserting the confident belief in the principles of separation of convicts during imprisonment by men whose high

character and large ability gave great weight to their opinion, the Legislature could not fail favorably to regard the prayers of the society

But it was not till 1821, that, after the last effort of the society to obtain the necessary and essential legislation, the law was passed on March 20, 1821, for the erection of a State Penitentiary within the city and county of Philadelphia.

Justice, simple justice, to the labors which resulted in the enactment of this law, and the men who secured its passage, makes it proper to give this memorial of the society on which the Legislature was induced to act. It is a statement, or the epitome of the reform, for the half century preceding its publication:

To the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met:

The memorial of the Philadelphia Society for Alleviating the Miseries of Public Prisons, respectfully represents:

That it is now nearly forty years since some of your memorialists associated for the purpose of alleviating the miseries of public prisons, as well as for procuring the melioration of the penal code of Pennsylvania, as far as these effects might be produced through their influence.

In performance of these duties which they believed to be required of them by the dictates of Christian benevolence and the obligations of humanity, they investigated the conduct and regulations of the jail, and likewise the effects of those degrading and sanguinary punishments which were at that period inflicted by the laws of this Commonwealth. The result of these examinations was a full conviction that not only the police of the prison was faulty, but the penalties of the law were such as to frustrate the great ends of punishment by rendering offenders inimical, instead of restoring them to usefulness in society.

With these impressions, alterations in the modes of punishment and improvements in prison discipline were from time to time recommended to the Legislature, by whose authority many changes were adopted, and many defects remedied.

These reforms, from the nature of existing circumstances, were, however, of comparatively limited extent, but as far as the trial could be made, beneficial consequences were experienced.

Neighboring States and remote nations directed their attention to these efforts, and, in many instances, adopted the principle which had influenced the conduct of Pennsylvania.

At the time of making the change in our penal code, substituting solitude and hard labor for sanguinary punishments, the experiment was begun in the county jail of Philadelphia, rather than the execution of the laws should be deferred to a distant period, when a suitable prison might be erected. Under all the inconveniences then subsisting, the effects produced were such as to warrant a belief that the plan would answer the most sanguine wishes of its friends, if it could be properly tried. But

the construction of that prison and its crowded condition, being the only penitentiary used for all the convicts of the State, leave but slender hopes of the accomplishment of the humane intentions of the Legislature.

Your memorialists believe that they discover in the recent measures of the Commonwealth, a promise which will fulfill the designs of benevolence in this respect. The edifice now in progress at Pittsburg for the reception of prisoners, constructed upon a plan adapted to strict solitary confinement, will go far towards accomplishing this great purpose; and your memorialists are induced to hope that the same enlightened policy which dictated the erection of a State prison in the western, will provide for the establishment of a similar one in the eastern part of the State.

Reasons of the most serious and substantial nature might be urged to show the absolute necessity which exists for a penitentiary in the city and county of Philadelphia, whether we regard the security of society or the restoration of the offenders against its laws. It will not be necessary here to recite the alarming proofs which might be adduced in support of their opinions, but refer to the documents herewith furnished, which exhibit the actual condition of the prison. Your memorialists, therefore, respectfully request that you will be pleased to take the subject under your serious consideration, and if you judge it right, to pass a law for the erection of a penitentiary for the Eastern District of the State, in which the benefits of solitude and hard labor may be fairly and effectually proved.

Signed by order and on behalf of the Society.

WILLIAM WHITE, *President.*
WILLIAM ROGERS, *Vice President.*
THOMAS WISTAR, *Vice-President.*

NICHOLAS COLLIN,
SAMUEL POWEL GRIFFITHS,
JOSEPH REED,
ROBERTS VAUX.

Attest: Caleb Cresson, *Secretary.*

This agitation of the reform in both the penal laws and system of convict punishment, though originating and developed in Philadelphia, extended to the western part of the State. On the 3d of March, 1818, the Legislature authorized the erection in the county of Allegheny, of a State penitentiary on the "solitary" plan, and in 1820 it was in the course of completion.

The non-association of prisoners being the primary object of the friends of the movement at its inception, and the congregation of all ages, sexes, and degrees of criminality being the gross evil sought to be abolished, it was necessary to suggest a method of incarceration which was in radical antagonism to the existing abuse. More intent in the trial of the proposition than in designating it by any special term, the word *solitary* seemed almost unconsciously to assert itself as the descriptive name of the reformed system. It was not in any sense the technical definition, and it

in some degree eliminated the idea of solitary, as contradistinguished to the associate or congregate relations of all prisoners in the county prisons or jails.

The use of this term "solitary" was most unfortunate in the first days of the trial of the new theory. Very much of the opposition that arose against it came from the misconception of the subject by the use of this word.

The Allegheny prison was designed by Mr. Haviland, an architect of Philadelphia, of very high professional repute. As there was no example on which to rely for the plan of the building intended for the complete and unexceptional *separation of convicts during imprisonment*, Mr. Haviland had to conceive the plan of the building from the information he could obtain from its advocates, and those few who were enlisted as its promoters.

The drawings for the Pittsburg prison, as it was called, were from the first impressions of what was necessary.

In 1821, when the Eastern or Philadelphia State Penitentiary was erected, Mr. Haviland's experience suggested many improvements, so that the Eastern Penitentiary, in 1829, when it was opened for the reception of convicts, was of course regarded as the true exposition of the *separate*, called however the *solitary*, system.

An examination of the corridors first erected prior to 1829, and those erected in 1872, will give the best idea of the improvements which experience made manifestly necessary.

Naturally so radical a change in the criminal law, act April 23d, 1829, and the mode of convict punishment, act March 20th, 1821, and the act of 28th March, 1831, as followed the partial completion of the *solitary* prison, and the enactment of these laws relating to crimes and penalties, caused discussion, hostilities, and opposition.

Better to condense the arguments of the friends and opponents of the Pennsylvania prison system, as it was then styled, the following extracts are given from then accepted authority:

Roberts Vaux, in his reply, 1827, to Mr. William Roscoe, of London, thus answers his chief objections:

"It is very evident to my mind that the true nature of the separate confinement which is proposed, requires explanation. I will, therefore, endeavor to describe what is intended by its friends. Previously, however, it ought to be understood that the chambers and yards provided for the prisoners are like anything but those dreary and fearful abodes which the pamphlet before me would represent them to be, 'destined to contain an epitome and concentration of all human misery, of which the Bastile of France and the Inquisition of Spain were only prototypes and humble models.' The rooms of the new penitentiary at Philadelphia are fireproof, of comfortable dimensions, with convenient courts to each, built on the surface of the ground—judiciously lighted from the roof—well-venti-

lated and warmed, and ingeniously provided with means for affording a continual supply of excellent water, to insure the most perfect cleanliness of every prisoner and his apartment.* They are, moreover, so arranged as to be inspected and protected without a military guard, usually though unnecessarily employed in establishments of this kind in most other States.

"In these chambers no individual, however humble or elevated, can be confined, so long as the public liberty can endure, but upon conviction of a known and well-defined offence, by a verdict of a jury of the country, and under the sentence of a court for a specific time. The terms of imprisonment it is believed can be apportioned to the nature of every crime with considerable accuracy, and will no doubt be measured in that merciful degree which has formerly characterized the modern penal legislation of Pennsylvania. Where, then, allow me to inquire, is there in this system the least resemblance to that dreadful receptacle constructed in Paris during the reign of Charles the Fi'th, and which at different periods, through four centuries and a half, was an engine of oppression and torture to thousands of innocent persons; or by what detortion can it be compared to the inquisitorial courts and prisons that were instituted in Italy, Portugal and Spain, between the years 1251 and 1537?

"With such accommodations as I have mentioned, and with the moderate duration of imprisonment contemplated on the Pennsylvania plan, I cannot admit the possibility of the consequences which thy pamphlet predicts, 'that a great number of individuals will probably be put to death by the superinduction of diseases inseparable from such mode of treatment.' I do not apprehend either the physical maladies so vividly portrayed, or the mental sufferings which, with equal confidence it is promised, shall 'cause the mind to rush back upon itself and drive reason from her seat.' On the contrary, it is my belief that less bodily indisposition, and less mortality, will attend separate confinement than imprisonment upon the present method, for which some reasons might be given that would be improper here to expose.

"By separate confinement, therefore, it is intended to punish those who will not control their wicked passions and propensities, thereby violating divine and human laws; and, moreover, to effect this punishment, without terminating the life of the culprit in the midst of his wickedness, or making a mockery of justice by forming such into communities of hardened and corrupting transgressors, who enjoy each other's society, and contemn the very power which thus vainly seeks their restoration and idly calculates to afford security to the State from their outrages in the future.

"In separate confinement every prisoner is placed beyond the possibility of being made more corrupt by his imprisonment, since the least associa-

* The exact size of the chambers is eight feet by twelve feet, the highest point of the ceiling sixteen feet. The yards are eight feet by twenty feet.

tion of convicts with each other must inevitably yield pernicious consequences in a greater or less degree.

"In separate confinement the prisoners will not know who are undergoing punishment at the same time with themselves, and thus will be afforded one of the greatest protections to such as may happily be enabled to form resolutions to behave well when they are discharged, and be better qualified to do so; because plans of villainy are often formed in jail which the authors carry into operation when at large, not unfrequently engaging the aid of their companions, who are thereby induced to commit new and more heinous offences, and come back to prison under the heaviest sentences of the law.

"In separate confinement it is especially intended to furnish the criminal with every opportunity which Christian duty enjoins for promoting his restoration to the path of virtue, because seclusion is believed to be an essential ingredient in moral treatment, and, with religious instruction and advice superadded, is calculated to achieve more than has ever yet been done, for the miserable tenants of our penitentiaries.

"In separate confinement a specific graduation of punishment can be obtained, as surely and with as much facility as by any other system. Some prisoners may labor, some may be kept without labor; some may have the privilege of books, others may be deprived of it; some may experience total seclusion, others may enjoy such intercourse as shall comport with an entire separation of prisoners.

"In separate confinement the same variety of discipline for offences committed after convicts are introduced into prison which any other mode affords can be obtained, though irregularities must necessarily be less frequent, by denying the refractory individual the benefit of his yard, by taking from him his books or labor, and, lastly, in extreme cases, by diminishing his diet to the lowest rate. By the last means the most fierce, hardened, and desperate offender can be subdued."

The attention of leading minds in Europe was directed to these experiments in Pennsylvania.

England sent, in 1834, Mr. Crawford, a commissioner, to examine the Eastern State Penitentiary. They were followed by Mr. Beaumont and Mr. DeTocqueville, from France, and by Dr. Julius, from Prussia. The investigations made by these very able men were so satisfactory that in those countries reforms were adopted which largely partook of the principles incorporated in the Pennsylvania prison system.

From the date of the opening of the Eastern State Penitentiary for the reception of convicts (1829) until 1845. the subject of the adaptation of the system to its design received the careful attention of those so earnestly devoted to the success of the experiment. There has been no legislative change in the system as adopted in the Eastern State Penitentiary since the act establishing it, 1821.

It would burden this paper to give the results reached as they were

developed. The criticisms which were made by those who doubted its practicability, who opposed its principle, who believed it would be injurious in its effects on those subjected to its operation, and who feared the cost would not pay for its benefits, were continued, and, strange it is to say, yet continue, though the experience of half a century refutes them.

The philosophy of "separate or individual treatment" of prisoners during incarceration is the basis on which this system rests.

The originators and early advocators of a method of convict punishment, which as they then knew was only to be the non-association of all criminals in a common jail, were content if this reform could be secured. Such a plan having been adopted and put in operation, the principle of the experiment of constant separation of individual convicts in prison became the subject of careful study.

The objections were magnified as it became apparent that the idea of making profit out of the associate labor of prisoners was, though a superficial, a popular view, addressed to both the prejudices and the susceptibilities of the tax-payer. In every other State then, but Pennsylvania, the congregate system was accepted because it was claimed that these prisons could be self-supporting. This delusion is now being dispelled. Yet these self-supporting prisons demanded the public favor, and to secure this result prisoners were sold to contractors, who paid a fixed sum per diem for their toil, and made from their associate work in shops, large profits for these employers. So great a stimulus to the greed of those interested, and the indifference of the public, at last resulted in changing the Pittsburg Penitentiary from the separate into a congregate prison.

It was left to the Eastern State Penitentiary to defend the separate method. The progress made in the adaptation of punishment to each individual case, as experience and careful study demonstrated was practically for the best interest of the prisoner and the community, became singularly satisfactory.

From 1845 to 1855 the advance in the development of the promised advantages to the convict and society of this reform in prison discipline, marked a new era in the history of convict punishment.

During this period the experience gained by the advocates of the separate system enabled the authorities of the Eastern Penitentiary to ascertain the improvements that were necessary both in the architecture of the building, and the method of administering the discipline.

The corridors and the cells as they then existed were found to be ill-suited to the special mode of management then being inaugurated. To indicate these changes, it may be stated that the rooms now, 1884, constructed for each prisoner, are eight feet wide, eighteen feet long, fourteen feet high, with double skylights in the ceiling, each five feet long by five and one-half inches inside width. There are air-tubes near the floor for outside ventilation. Each room has gas, fresh water, and a closet with perfect drainage, through a pipe four inches in diameter, into a ten-inch

main filled with water, flowing into a sewer, all flushed daily. The moral effect of these surroundings of each prisoner cannot be overestimated.

It was not until 1870 that the knowledge acquired by those directly connected with the administration of the Eastern State Penitentiary, was so thoroughly digested as to justify them in establishing the changes in the treatment of the prisoners, and the improvements in the buildings erected in 1877, which give to this institution its present characteristics. It is now attracting the close examination of the most enlightened men of America and Europe. France is earnestly investigating it, and the Prison Society of Paris preëminently leads the exposition of its methods. These changes from the original structure of the cells, and the relations of the prison authorities with the prisoners are best described as radical. Philosophy has consummated what philanthropy originated, and experience has developed what the founders of the Pennsylvania prison system were not gifted to foresee. These men, worthy as they are of the highest commendation, began an experiment out of which have been evolved principles of science that, now in operation, create new and distinctive duties and responsibilities between society and its criminals.

The present system of convict punishment as administered in the Eastern State Penitentiary can best be described as the individual treatment method of applying punishment for crime. It formulates this reform on positive philosophic principles.

The individual commits crime from motives with which the will, characteristics, inherited traits and training are related. This crime-cause is different in each case. The crime is the development of these concurrent influences. Society has suffered by the act of this person. It demands an expiation in some sort for the premeditated wrong. Security for either the rights of property or the rights of persons has been impaired by this act. The offender must be punished. It must be an example expressing the supremacy of law, the prevention of crime, and the purpose of restoring the offenders to society, instructed and strengthened, if so be, for good citizenship. The offender is convicted for the crime and the court sentences him to imprisonment. He is thus placed where his punishment can be applied. From the conception of the crime, in its commission, at the trial, conviction and sentence, the prisoner's individuality asserts itself. These antecedents crystallize round the individual. His punishment, to be effective, should therefore be applied to him as an individual. Separated from all other prisoners, the means which his case requires can be best discovered and best adapted to obtain the result society demands.

Under these conditions each prisoner is subjected to the discipline. Whatever may serve to elevate his moral character and strengthen it, to induce reform and inspire better aims in life, are addressed to his developing remorse. Special aptitudes and particular capacities are cultivated. Books for instruction and labor for training to industry are regarded as essential. A certain sum is allowed, over the cost of maintenance, for the prisoner to aid in the support of his family, or for himself when he is

released. Visits from his family and judicious persons are encouraged. Every prisoner is, therefore, treated as his case requires. The purpose as to each of all is to try and change his course of life, and thus benefit him and society. It is believed this method is successful in a large majority of first convictions of first offenders.

Incarceration is not punishment, it is only the condition under which it may reasonably be applied. Continuous labor during incarceration does not in itself constitute the entirety of punishment. It should be, however, adopted as an instruction, an element or marked feature in the discipline, with other instructions in the process of making punishment a personal benefit and an advantage to the public. Teaching a prisoner a trade, by which he may become self-supporting on his release from punishment, is a gain both for him and the community. That is labor which pays in morals, and as an industry intended to be both punitive and reformatory, it pays as an economy. It is doubtful if the man or the State gains any practical good by the incarceration at labor only, of violators of law. It is not doubtful that the outcome of congregating convicts at labor as their only punishment is dangerous to the general security. From this association a crime-class is established to war on the general welfare as its occupation. Punishment should attempt to reconstruct the enfeebled or irrational or misdirected character.

To discover the crime-cause, the weaknesses, the untaught and corrupted conditions and the positive needs of each convict is the antecedent of any rational method for his treatment in prison, and for the application of any moral alterative or corrective. This is undoubtedly the purpose, the aim and the gain of punishment. In this view the subject is elevated out of the domain of benevolence to the character of an important social science. It is this philosophy which regulates and characterizes the individual treatment of the Eastern State Penitentiary. To attain this purpose requires trained and competent officials, who, by long service, become qualified for their duties. It must be for them a vocation. Their tenure of positions must originate in high character, and continue with their usefulness in their responsible trust.

In the fifty-three annual reports of the Inspectors of the Eastern State Penitentiary will be found the history of the growth of the experiment which originated in Philadelphia a century ago. These reports, from the year 1829 to the present time, contain very interesting descriptions of the merits, and the objections to the separate system, and, from 1870 to 1883 inclusive, a thorough explanation of the changes and improvements in the system, and an exposition of the scientific principles which underlie them.

It may be justly claimed that the reforms in prison systems, or their administration, in the United States, as well as in foreign countries, are the out-come of the century of labors, efforts, and experience of the benevolent and philosophic men who in Philadelphia originated and have given to the Pennsylvania system its renown.

And it may with equal justice be maintained that those reforms in con-

vict punishment which are now so general are identified with the initial experiment in the Commonwealth of Pennsylvania.

It would doubtless be out of place in this paper to discuss the evils which attach to the profit-making congregate prisons.

The peril to society, the corrupting influences, the degradation and training in crime, which are inseparably connected with association of convicts, must exist while it is maintained.

It need only be stated that in old communities, or States where those who are convicted of crimes, of whatever physical and mental condition, capables and incapables, are indiscriminately incarcerated in a prison on the congregate, profit-making, self-supporting plan, the outcome exceeds the income. As a fact, under all the circumstances, such institutions cannot be proved to yield a profit to the State.

The theory of self-supporting congregate prisons under the conditions just mentioned is not always sustained. The sturdy adults, selected from the aggregate of all persons convicted in a State, may yield by their associate labor a profit to the prison. If so, then such a prison is a State manufactory. This is not regarded as a judicious adaptation of the purpose of a penal institution for the punishment of offenders against social security.

The State Penitentiary at Philadelphia is the only institution in the United States in which the "Individual treatment system" is administered. In England some of its features are engrafted on the penal discipline of its prisons, so far as the social conditions of that country accept them as practical. In France, Belgium, and Italy, greater progress than elsewhere in Europe has been made in adopting the separate plan in the prisons of those nations.

In some of the States of the Union there is a gradual approach to the principle of separation of convicts in prison, and a tacit acknowledgment of the value of the Pennsylvania system. The chief obstacle to a more thorough conformity is the proclaimed cost. It is hardly possible to convince those who legislate for, or conduct State penal institutions, even in States claiming to be enlightened, that any plan which does not pay its expenses is for the general interest of the people. Under this pretext this general delusion is vitalized. Till it shall be acknowledged a delusion, and the substantial interests of the public best considered by adopting the reform which is slowly manifesting its value, the Pennsylvania system must wait for its coming triumph. How long a period may intervene is problematical. Be it as it may, it must not deter or dishearten. The process of development in social science is necessarily deliberate. The consideration and clear comprehension of the relations of society to the violators of its laws are unattractive to the mind of the public. The code defining crimes changes as social conditions change. Education, heredity, customs, prejudices, false training, insubordination, and bad association, are among the incentives to unregulated individual conduct in communities, and thence crime is the outcome. How to deal with these

changing social growths is best to be found in the philosophy of the individual treatment of crime-cause, and its appropriate remedies.

That such a conclusion will be reached, as penology is studied, is most likely. If so, it will be the conviction of the judgment which comes from the demonstration of the principles which, since 1790, in this city have been taught as the science of convict punishment. This advance will be slow. It must be remembered that Beccaria in his essay on "Crimes and Punishment" in 1764; Filangieri in his "Science of Legislation" in 1780 and Montesquieu in his "Spirit of the Laws," 1748, were among the first to invite attention to penal jurisprudence. A century elapsed before practical advantages testified to the effect produced from this discussion of the subject. The Pennsylvania prison system rests its claim for recognition and adoption on the suggestions of philosophy, and the teaching of experience, confirmed by half a century of trial. It must teach, and wait.

Notes on the Stromateidæ. By Theodore Gill.

(Read before the American Philosophical Society, July 18th, 1884.)

The grave errors into which Dr. Günther seems to have fallen in the treatment of certain forms of this family furnish my excuse for the present communication. Dr. Günther has reiterated, without change, opinions enunciated twenty years ago, and he still separates widely forms of one of the subfamilies of this family, dispersing representatives thereof among four of his "families" and associating them in several cases with forms with which they have no affinity. Following Dr. Günther in the first instance Dr. Day has also misunderstood one of the types in question, and Dr. Lütken has likewise been deceived as to the relationships of the same form.

The family, as here understood, is co-equal with the Stromateidæ of Dr. Günther, with the addition of several types widely scattered by that gentleman. It embraces in fact, (1) the Stromateidæ recognized as such by Dr. Günther, (2) the genus *Pammelas* of his *Carangidæ*, (3) the species *Psenes anomalus* of his *Nomeidæ*, and (4) the genus *Schedophilus* of his *Coryphænidæ*. There are two quite distinct types in the group thus constituted, (1) one represented by *Stromateus* and its allies, and (2) the other by *Centrolophus* and relatives. These are distinguished by differences in the development of the vertebræ, the former having 14–15 abdominal and 17–21 caudal vertebræ, and the latter 11 abdominal and 14 caudal vertebræ; these differences are supplemented by variations in the degree of complexity of the peculiar appendages representing and homologous with the gill-rakers of ordinary fishes, developed from the last branchial arch, and extending into the œsophagus. It is quite possible, therefore, that the two types, now retained as sub-families under the old names *Stroma-*

teinæ and *Centrolophinæ*, should be distinguished as families. It is only the want of sufficient data respecting the several genera that delays such a recognition at the present time.

The Centrolophinæ appear to be the most generalized type, the ventrals being fully developed and retained in all stages, the dorsal and anal spines normally developed, and the preoperculum in some always retaining the spines characteristic of the youth of the Scombroid fishes, while the Stromateinæ contrast more or less in all these several features, and also have more specialized gill-rakers or processes.

A summary of the known types of the family will give the means of better appreciating the relations of the forms to be specially considered.

Family STROMATEIDÆ.

Synonymy.

>Stromatini, *Rafinesque*, Indice d'Ittiolog. Siciliana, p. 39, 1810.
×Fiatolides, *Risso*, Hist. Nat. de l'Europe Mérid., t. 3, pp. 107, 287, 1826.
×Stromateidæ, *Adams*, Manual Nat. Hist., p. 98, 1854.
>Stomateidæ, *Günther*, Archiv für Naturg., 28. Jahrg., B. 1, p. 59, 1862.
=————, *Gill*, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 126, 1862. (Indicated but not named or defined.)
>Stromatei, *Fitzinger*, Sitzungsber. K. Akad. der Wissench. (Wien), B. 67, 1. Abth., p. 32, 1873.
>Stromateidæ, *Günther*, Int. to Study of Fishes, p. 452, 1880.
=Stromateidæ, *Jordan and Gilbert*, Syn. Fishes N. Am., p. 449, 1882.
Scombroides gen., *Cuvier et al.*
Psettoidei gen., *Bleeker.*
Coryphænoidei gen., *Bleeker.*
Coryphænidæ gen., *Günther.*
Carangidæ gen., *Günther.*
Nomeidæ sp., *Günther.*

Scombroidea with an elongated dorsal whose foremost rays only are more or less spiniform and the gill-rakers of the upper segment of the last branchial arch enlarged and dentigerous or sacciform, and projecting backwards into the œsophagus.*

Body generally compressed, with the form regularly ovate or sub-orbicular, but sometimes more or less oblong or elongate, highest near the scapular region, and with the caudal peduncle suddenly constricted and slender.

Anus in the anterior half of the body.

Scales small, cycloid and smooth.

Lateral line nearly concurrent with the dorsal outline.

Head compressed, generally higher than long, with the profile more or less decurved in proportion to the height, and with the snout more or less convex. Eyes submedian or anterior.

* "The œsophagus is armed with numerous bony, barbed teeth," *Günther*, Cat. Fishes B. M., v. 2, p. 307.

Suborbital bones small.

Opercular bones normally developed

Nostrils double, in front of each eye.

Mouth terminal, moderate or small, with the cleft lateral and little oblique.

Upper jaw in some (Stromateinæ) not protractile, in others (Centrolophinæ) protractile.

Teeth small and pointed, absent from the palate.

Branchial apertures variable.

Branchiostegal rays variable (5 to 7).

Dorsal fin commencing at the nape or behind the bases of the pectorals, elongated, and with few small or rudimentary and often modified spines in front; the soft rays branched.

Anal fin commencing behind the anus and coterminal with the dorsal, to which it is similar in form and structure, but with fewer spines in front.

Caudal fin more or less emarginated or forked.

Pectoral fins inserted rather high on the sides, well develeped and pointed or rounded.

Ventral fins thoracic or jugular when present, often absent (obsolete in the old, but developed in the young of some species).

Branchiæ 4, with a cleft behind the last.

Pseudobranchiæ developed.

The *pharyngeal bones* beneath are separated.

The *stomach* is cœcal, and the *pyloric appendages* in some numerous or dendritic, and in others developed in moderate number.

Subfamily CENTROLOPHINÆ.

Synonymy.

=Centrolophinæ, *Gill*, Cat. Fishes E. Coast N. Am., p. 34 (not defined), 1861.

=Centrolophinæ, *Gill*, Proc. Acad. Nat. Sci. Phila., p. 127 (not defined, but genera enumerated), 1862.

=Centrolophinæ, *Jordan and Gilbert*, Syn. Fishes N. Am., p. 450, 1882.

Coryphæninia gen., *Bonaparte*, 1831, 1838, 1840, 1846, 1850.

Stromateina gen., *Günther*.

Coryphænina gen., *Günther*.

Carangina gen., *Günther*.

Nomeina sp., *Günther*.

Stromateidæ with complex elongate gill-rakers, extending backwards from the epibranchials of the last branchial arch, 11 abdominal and 14 caudal vertebræ, protractile premaxillaries, and normally developed ventral fins (1.5) persistent through life.

Although the constituents of this subfamily have been widely scattered, and still continue to be, their relations were appreciated and contended

for more than a score of years ago. One of the genera has had a singular history, which may be detailed more at length hereafter. Suffice it now to state that one species was originally described as a *Centrolophus*, and subsequently differentiated as a peculiar generic type under the names *Leirus* and *Mupus*, while another closely related was originally introduced as a *Coryphæna*, again as a *Trachynotus*, and afterwards distinguished as a new genus *Palinurus*, near *Trachynotus*. The name *Palinurichthys*, was substituted for it Nov., 1859, by Bleeker and about the same time,* in Jan., 1860 (Proc. Acad. Nat. Sci., Phila., 1860, p. 20), Gill also independently proposed the name *Palinurichthys* as a substitute for *Palinurus*. In the "Catalogue of Fishes of the Eastern Coast of North America," published in Feb., 1861 (p. 34), it was referred to the sub-family Centrolophinæ. In critical remarks on Dr. Günther's composition of the Scombroid families ("On the Limits and Arrangement of the Family of Scombroids"), published in March, 1862 (Proc. Acad. Nat. Sci. Phila., 1862, p. 127), it was claimed that "nearly allied to the preceding [Stromateinæ] are the Centrolophinæ, with the genera *Centrolophus* Lac., *Leirus* Lowe, and *Palinurichthys* Gill, Blkr. (=Pammelas Gthr.). Closely connected to the Centrolophinæ are the genera *Schedophilus* Cocco and *Hoplocoryphis* Gill (type *Schedophilus maculatus* Gthr.)." A few lines further it was again remarked that among the forms that should be withdrawn from the Carangidæ was "*Pammelas* Gthr., which is nearly allied to *Centrolophus*." Finally, in Gill's new "Catalogue of the Fishes of the Eastern Coast of North America" (1872, p. 9), *Palinurichthys* was enumerated under the family "Stromateidæ" and the subfamily "Centrolophinæ." Notwithstanding these explicit statements the genus has been retained by Dr. Günther and Dr. Day next to *Trachynotus*, with which it has no affinity whatever. Its anatomy conclusively shows that the view, originally formed by the author from a consideration of its exterior, is perfectly correct. It has the number of vertebræ, epibranchial processes, &c., of *Centrolophus*, and in fact is scarcely, if at all, distinguishable from *C. ovalis* of European authors.

Centrolophus.

Synonymy.

=Centrolophus, *Lacépède*, Hist. Nat. des Poissons, t. 4, p. 441, 1802.
<Centrolophus, *Cuvier*, Règne Animal, 2 ed., t. 2, p. 216, 1829.
<Acentrolophus, *Nardo*, Prodr. Ichthyol. Adriat., sp.
<Centrolophus, *Cuvier and Valenciennes*, Hist. Nat. des Poissons, t. 9, p. 330, 1833.
=Pompilus, *Lowe*, Proc. Zool. Soc. London, 1839, p. 81.
Coryphæna sp., *Linnæus*, etc.
Perca sp., *Gmelin*.
Holocentrus sp., *Lacépede*.

*The paper in the Proc. Acad. was probably published earlier than Dr. Bleeker's, but happily the question is immaterial.

Centrolophinæ with an elongated body, and very slender spines, scarcely distinguishable externally from the succeeding rays.

Type *C. pompilus* = *Coryphæna pompilus* Linn.

SCHEDOPHILUS.

Synonymy.

=Schedophilus, *Cocco*, Giorn. Innom. Messin., anno 3, No. 57, p. 57 (fide Bon.) 1834?

=Schedophilus, *Bonaparte*, Fauna Italica, iv, Pesci, fol. 127 (marked 133), 1839.

Centrolophus sp., *Cocco*.

Crius sp., *Valenciennes*.

Centrolophinæ with an oval contour, about four short, stout spines constituting the foremost part of the dorsal, and a declivous or slightly protuberant snout.

S. medusophagus = *Centrolophus medusophagus* Cocco.

The generic characters of this type, if distinct, have not yet been satisfactorily contrasted with those of *Leirus*. There is a singular discrepancy between the several figures of the types, most of which can, however, be satisfactorily accounted for.

LEIRUS.

Synonymy.

??Lepterus, *Rafinesque*, Caratteri di alcuni n. gen. e n. sp. Animali e Piante della Sicilia, p. 52, pl. 10 (D. ii, 30; A. i, 14; P. 20; V. i,5), 1810.

??Lepipterus, *Rafinesque*, Indice d'Ittiologia Siciliana, p. 16, 1810.

=Leirus, *Lowe*, Proc. Comm. Zool. Soc., London, pt. 1, p. 143; Trans. Cambridge Phil. Soc., v. 6, p. 199, pl. 5, 1833.

=Mupus, *Cocco*, Giorn. Innom. Messin. ann. —, p. —.

<Crius, *Valenciennes*, Hist. Nat. des Iles Canaries, par Webb and Berthelot, t. 2, part 2, Poissons, p. 45, 1836–44.

=Palinurus, *Dekay*, Zoology of New York, pt. 4, p. 118, 1842.

=Mupus (*Cocco*), *Bonaparte*, Cat. Met. dei Pesci Europei, p. 77 (name only), 1846.

=Palinurichthys, *Bleeker*, Enum. sp. Pisc. Archipel. Ind., p. 23, Nov., 1859.

=Palinurichthys, *Gill*, Proc. Acad. Nat. Sci. Phila. [v. 12], p. 20, Jan., 1860.

=Pammelas, *Günther*, Cat. Fishes in Brit. Mus., v. 2, p. 485, 1860.

=Leirus, *Jordan and Gilbert*, Syn. Fishes N. Am., p. 452, 1882.

Coryphæna sp., *Mitchill*.

Trachinotus sp., *Storer*.

Centrolophus sp., *Cuv. and Val.*, *Günther*, etc.

Pompilus sp., *Lowe*.

Centrolophinæ with an oval contour, six to eight short stout spines constituting the foremost part of the dorsal, and a protuberant snout.

Type *L. ovalis* = *Centrolophus ovalis*, C. V.

It is possible, perhaps probable, that the fish from which the following very unsatisfactory description was taken by Rafinesque was a specimen of the typical species of this genus.

"XXXIII. G. Lepterus.—Capo troncato senza squame, dei denti alla mascella, inferiore sola nente, opercolo doppio, l'esterne spinoso, l'interno dentelato, base dell'ale dorsale, anale e caudale [p. 53] ricoperte *di* squame, una sola ala dorsale con pochi raggi spinosi.—*Oss.* Il Carattere che distingue particolarmente questo genere dall' *Holocentrus* si è quello delle sue ale squamose.

"142. *Sp.* Lepterus fetula.—Nero al disopra, bianco al disatto, linea laterale curva nel mezzo, coda forcata, ala dorsale con 32 raggi di cui 2 spinosi, l'ala anale con 15 di cui 1 è spinoso.—*Oss.* Porta il nome di *Fetula*, è raro e poco stimato, ha alcuni piccoli denti acuti alla parte anteriore della mascella inferiore, l' iride bianca, le ale pettorali con 20 raggi e le toraciche con 6 di cui il primo é spinoso; la sua lunghezza è di circa mezzo piede."

Subfamily STROMATEINÆ.

Synonymy.

×Stromatia, *Rafinesque*, Analyse de la Nature, p. —, 1815.

<Stromateini, *Bonaparte*, Iconografia della Fauna, Italica, t. 3, Pesci, fol. 125 (contains *Stromateus*, *Peprilus*, *Luvarus* and *Kurtus*), 1834.

<Stromatinæ, *Swainson*, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 177, 253, 1839. (Includes *Sesirinus*, *Stromateus*, *Peprilus*, *Kurtus* and *Keris*.)

<Stromateini, *Bonaparte*, Nuovi Annali delle Sci. Nat., t. 2, p 133, 1838; t. 4, p. 275, 1840.

<Stromateina, *Günther*, Cat. Fishes in Brit. Mus., v. 2, pp. 355, 397, 1860.

=Stromateinæ, *Gill*, Cat. Fishes E. Coast N. America, p. 35, 1861.

=Stromateinæ, *Gill*, Proc. Acad. Nat. Sci. Phila., 1862, p. 126, 1862.

=Stromateinæ, *Jordan and Gilbert*, Syn. Fishes N. Am., p. 450, 1882.

Stromateidæ with 14–15 abdominal and 17–21 caudal vertebræ, sacciform processes extending backwards from the hindmost branchial arch, non-protractile premaxillaries, and with the ventral fins generally early atrophied or lost, and absent in adult—rarely persistent.

Dr. Lütken recognizes two genera of Stromateinæ, viz.:

I. Stromateus.

Stromateinæ with ample branchial apertures.

In 1862 Gill proposed to subdivide this type into four genera or subgenera, viz.:

1. Stromateus.

Synonymy.

<Stromateus, *Artedi*, Genera Piscium, p. 19, 1738.
<Stromateus. *Linnæus*, Systema Nature, ed. x, t. 1, p. 248, 1758; ed. xii, t. 1, p. 432, 1766.
×Chrysostrome, *Lacépède*, Hist. Nat. des Poissons, t. 4, p. 698, 1802.
<Fiatola, *Cuvier*, Règne Animal [1re éd.], t. 2, p. 342, 1817. (Subgenus.)
<Stromateus, *Cuvier*, Règne Animal [2e éd.], t. 2, p. 212, 1829.
>Seserinus, *Cuvier*, Règne Animal [2e ed.], t. 2, p. 214, 1829.
<Stromateus, *Cuv. & Val.*, Hist. Nat. des Poissons, t. 9, p. 372, 1833.
×Stromateus, *Günther*, Cat. Fishes in Brit. Mus., v. 2, p. 397, 1860.
=Stromateus, *Gill*, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 126, 1862.
Stromateus sp. *auct.*

Stromatei with uniform dorsum, little produced dorsal and anal fins, and without an obvious pelvic spine.

Type *S. fiatola* Linn.

2. Peprilus.

Synonymy.

<Peprilus, *Cuvier*, Règne Animal [2e ed.], t. 2, p. 213, 1829.
<Rhombus, *Cuvier and Valenciennes*, Hist. Nat. des Poissons, t. 9, p. 401, 1833.
Chætodon sp., *Linn.*
Sternoptyx sp. *Bloch and Schneider.*
Stromateus sp., *Mitchill*, etc.

Stromatei with uniform dorsum, dorsal and anal fins extended vertically in front, and with a trenchant pelvic spine.

Type *P. alepidotus* = *P. longipinnis* Cuv., ex. Mitchill.

3. Poronotus.

Synonymy.

=Poronotus, *Gill*, Cat. Fishes E. Coast N. Am., p. (not defined), 1861.
Stromateus sp., *Peck*, etc.
Peprilus sp., *Cuv.*
Rhombus sp., *Cuv. and Val.*

Stromatei with a row of vertical slits on each side of the back between the dorsal fin and lateral line, with little extended vertical fins, and with a trenchant pelvic spine.

Type *P. triacanthus* = *Strom. triacanthus* Peck.

4. Apolectus.

Synonymy.

=Apolectus, *Cuv. and Val.* Hist. Nat. des Poissons, t. 9, p. 438, 1833.
Stromateus sp. *Bloch*, *Bleeker*, etc.

Stromatei with the lateral line keeled and shielded behind.

Type *A. niger* = *A. stromateus Cuv. and Val.*

II. Stromateoides.

Stromateinæ with restricted branchial apertures and without ventrals. There appears to be two types under this group, viz:—

1. Stromateoides.

Synonymy.

<Pamples, *Cuvier*, Règne Animal [2e ed.], t. 2, p. 212, 1829.
<Pampus, *Bonaparte*, Fauna Italica, iii, Pesci, fol. 125,* 1834.
<Stromateoides, *Bleeker*, Bijdrage tot de kennis der makreelachtige Visschen van den Soenda-molukschen archipel, pp. 19–20, *in* Verhandl. bataav. Genootsch., v. 24, 1857.
<Stromateoides, *Lütken*, Vidensk Selsk. Skr. (5), Nat. og Mathem. Afd., v. 12, pp. 523, 602, 1880.
Stromateus sp., *Bloch*, *Günther*, etc.

Stromateoides with higher body, elevated vertical fins, and prominent and extended trenchant dorsal and anal spines.

Type *S. cinereus* Blkr., ex Bloch.

2. Chondroplites.

Synonymy.

=Chondroplites, *Gill*, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 126 (not defined), 1862.
Stromateus sp., *Euphrasen*, etc.
Stromateoides sp., *Bleeker*. *Lütken*.

Stromateoides with more oblong body, little elevated dorsal and anal fins, and concealed and subcartilaginous dorsal and anal spines.

Type *C. sinensis* = *Strom. sinensis*, Euphrasen.

Psenopsis.

Synonymy.

=Psenopsis, *Gill*, Proc. Acad. Nat. Sci. Phila., 1862, p. 157, 1862.
Trachinotus sp., *Temminck and Schlegel.*
Psenes sp., *Bleeker*, *Günther*, *Lütken*.

Stromateinæ with persistent perfect ventrals (I, 5) and about 6 normal spines constituting the front of the dorsal fin.

Type *P. anomalus* = *Trachinotus anomalus*, T. and S.

The following genus may be mentioned in this connection because the *Leirus perciformis* as well as *Psenopsis anomalus* have been referred to it. Its affinities are uncertain.

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* "Diamo il nome di *Pampus* al secondo sottogenere in cui accogliamo quelle specie che non hanno pinine ventrali, e portano innanzi ai raggi delle dorsali e dell' anale parecchie spine terminate superiormente da una lamina tagliente." Bonaparte.

PSENES.

Synonymy.

Psenes, *Cuvier and Valenciennes*, Hist. Nat. des Poissons, t. 9, p. 259.
Cubiceps, *Lowe*, Proc. Zool Soc. London, p. 82, 1843.
Atimostoma, *Smith*, Illust. Zool. S. Africa Fishes.
Navarchus, *Filippi and Verany*, Mem. Acad. Sci. Torin. (2), t. 18.
Trachelocirrhus, *Doumet*, Revue et Mag. de Zool., t. 15, p. 212, 425, etc., 1863.
Cubiceps, *Günther*, Cat. Fishes in Brit. Mus., v. 2, p. 388, 1860.
Psenes, *Günther*, Cat. Fishes in Brit. Mus., v. 2, p. 494, 1860.

These synonyms are given chiefly on the authority of Dr. Lütken (Vidensk. Selsk. Skr. (5), Nat og Math Afd., v. 12, pt. 6, pp 513, 601).

The genus named *Schedophilopsis* by Dr. Steindachner* under the supposition that it was nearly related to *Schedophilus*, has considerable superficial likeness to that genus, but apparently does not belong to the same family, and had received the slightly prior name *Icosteus* It is the representative of a peculiar family, *Icosteidæ*, in Jordan and Gilbert's Synopsis (p. 619).

Stated Meeting, Aug. 15, 1884.

Present, 2 members.

An acceptance of membership was received from Dr. W. W. Keen, dated Philadelphia, July 19th, 1884.

Letters of acknowledgment were received from the New Bedford Library; Yale College; University of the City of New York and Prof. J. J. Stevenson; U. S. Naval Institute; Library of Congress; United States Surgeon-General's Office; United States Naval Observatory; United States Geological Survey, and the Chicago Historical Society (all for No. 115).

Donations to the Library were received from the Egyptian Institute; the Department of Mines, Melbourne; the Geological Survey of India; the Netherland Archives; the Royal Society of Northern Antiquaries; the Geological Society of Switz-

*Schedophilopsis = Schedophilopsis *Steindachner*, Anzeiger Math. Nat. d. K. Akad. Wissensch. zu Wien., 1881, p. 100 (*S. spinosus*), 1881.

erland; Prof. E. Renevier; the Society of Sciences at Liège; M. E. Folie; M. Paul Albrecht; the Reale Accademia dei Lincei; the Observatory at Turin; M. Alessandro Dorna; M. Damiano Muoni; the Revue Politique; the Ecole des Mines; the Geographical Societies of Paris and Bordeaux; the R. Academy of History in Madrid; the Royal Meteorological Society; London Nature; Mr. Benjamin Ward Richardson; M. F. Hugh O'Donnell; Rev. John Presland; Mr. Lewis Appleton; the Essex Institute; Prof. C. H. Hitchcock; the Boston Society of Natural History; the American Academy of Arts and Sciences; the Astronomical Observatory of Harvard College; the American Journal of Science; the New York Meteorological Observatory; the American Museum of Natural History; Mr. A. N. Bell; J. & J. D. Nolan; the College of Pharmacy; Franklin Institute; Pennsylvania Historical Society; the Engineer's Club; Mr. Benjamin S. Janney; M. Leopold Delisle; Dr. Persifor Frazer; Mr. E. D. Cope; Major M. Veale; the United States Naval Institute; Johns Hopkins University; Chief of Engineers, United States Army; United States National Museum; United States War Department; Mr. Jed. Hotchkiss; Mr. Wm. A. Courtnay; Rev. Stephen D. Peet; and the Academy of Science at St. Louis.

The death of Ferdinand Von Hochstetter, at Vienna, July 18, 1884, aged 55 years, was reported by the Secretary.

Communications from Prof. E. D. Cope were received as follows:

"On the Structure of the Feet in the Extinct Artiodactyla of North America."

"Fifth Contribution to the Knowledge of the Fauna of the Permian Formation in Texas."

The President reported that he had appointed Messrs. Lesley, Phillips, Ingham, Rushenberger, Barker and Brinton, to meet the requirements of the resolution of the Board and Council, adopted Feb. 8, 1884.

And the meeting was adjourned.

Stated Meeting Sept. 19, 1884.

Present, 4 members.

Letters accepting membership were received from Edward W. Syle, D.D., 609 Walnut Street, Philadelphia, August 29th; from Sir John Lubbock, dated High Elms, Hayes, Kent, August 6; and from N. A. Randolph, M.D., University of Pennsylvania, Medical Department, August 9, 1884.

Acknowledgments were received from the Cambridge Library, England (110, 111, 112); W. L. Stevens (115); the Royal Academy of Sciences and Royal Zoölogical Society, Amsterdam (110, 111, — 112); the Franklin Institute (115); and the Maryland Historical Society (115).

Letters of envoy were received from the Musée Guimet, August 23; the Manchester Library and Philosophical Society; and the Cambridge Library, England, June 30.

An invitation was received to assist at the Twenty-fifth Anniversary of the Natural History Society, at Chemnitz.

A circular letter was received from Gen. C. B. Norton, respecting the American Exhibition of 1886, at London.

Donations to the Library were received from the Geological Survey of India; the Academy of Sciences at Batavia; the Royal Society of New South Wales; the Office of Mines at Melbourne; the Royal Society of Tasmania; the Physical-Central Observatory at St. Petersburg; the Imperial Society of Naturalists at Moscow; the Imperial Royal Central Institute, Geological Reichsanstalt, Zoölogico-Botanical, and Geographical Societies at Wien; M. August Tischner at Leipzig; the Scientific Society of Upper Lusatia; the Royal Prussian Academy and German Geological Society at Berlin; the Royal Danish Society of Sciences; the Institute of the Grand Duchy of Luxembourg; the Royal Academy of Sciences at Amsterdam; the Holland Society of Sciences, and Tyler Museum; the Royal Academy of Sciences, Royal Observatory and Department of the Interior at Brussels; the Venetian Institute of Sciences; the Royal Academy of Sciences at Turin; the

Academy of the Lincei; the Royal Geological Committee of Italy; the Tuscan Society of Natural Sciences; the Anthropological, Zoölogical, and Geographical Societies at Paris; the Musée Guimet; the Royal Academy of History at Madrid; the Philosophical Society of Great Britain, the British Association for the Advancement of Science, Royal Observatory, Meteorological Office, International Forestry Exhibition, the Royal Asiatic, Geographical, Zoölogical, Geological, Astronomical, Linnean and Antiquarian Societies and Nature, London; the Royal Cornwall Polytechnic Society; the Manchester Literary and Philosophical Society; the Royal Irish Academy; the Royal Society of Canada; S. E. Cassino & Co.; American Philological Association; A. Agassiz and F. D. Whitney; the American Antiquarian Society; the American Journal of Science; the Torrey Botanical Club of New York; Dr. William G. Stevenson, of Poughkeepsie; the Franklin Institute, the College of Pharmacy, J. P. Lesley and Henry Phillips, Jr.; the American Chemical Journal, American Journal of Philology, Johns Hopkins University, and Edward Ingle, of Baltimore; the United States National Museum, the United States Fish Commission, the Smithsonian Institution, and Mrs Erminnie A. Smith, of Washington; J. Hotchkiss, of Staunton, Virginia; Charles Colcock Jones, Jr., of Atlanta, Georgia; the Colorado Scientific Society, and M. Rafael Mallen, of Mexico.

The death of Mr. Henry M. Phillips, at Philadelphia, August 29th, aged 73, was announced.

The death of Prof. Robert E. Rogers, M.D., at Philadelphia, September 6th, aged 77, was announced.

"Thermometrical Observations at Quito, Ecquador, taken by Mr. C. B. Brockway, from September 17, 1858, to June 18, 1859," was presented by the Secretary, with a letter from Mr. Brockway, dated September 6th, 1884, in which he says:

"I would call the attention of whoever examines the table to the equability of the temperature and that the heavy earthquake shocks did not materially vary it. Since Humboldt's stay at the Equator I think that no official observations have been taken."

And the meeting was adjourned.

Thermometrical Observations in Quito, Ecuador. Farenheit. C. B. Brockway.

(Read before the American Philosophical Society, September 19, 1884.)

DATED 1858.		9 A. M.	12 M.	3 P. M.	9 P. M.	REMARKS.
September	17			66°	64°	Elevation above sea level 9492 feet.
"	18	65°	66°	65	61	Latitude 0° 15′ S., Longitude 78° 45′ W.
"	19	63	65	63	61	
"	20	62	65	65	62	
"	21	60	62	62	61	
"	22	61	63	64	61	
"	23	61	63	63	62	
"	24	61	63	63	58	
"	25	60	63	62	60	
"	26	61	62½	62	58	
"	27	59	62	62	60	
"	28	60½	62	62	61	
"	29	60	62½	63	61	
"	30	61	64	62½	60	
October	1	59	60	60	56	Rain in the afternoon.
"	2	60	61	60	53	Rainy until near evening.
"	3	60	61	62	59	Clear.
"	4	60	61	63	54	"
"	5	59	62	64	53	Hail and rain in afternoon.
"	6	61	64	64	55	Clear.
"	7	61	63	64	55	Cloudy after 4 P.M.
"	8	62	63	64	54	Cloudy from 4 to 6 P.M. Comet visible in evening.
"	9	61	63	64	60	Morning and evening clear. A little rain in afternoon.
"	10	61	62	63	60	Clear.
"	11	59	62	64	55	"
"	12	54	62	63	56	"

October	13	60	63	64	56	Clear.
"	14	59	62	62	55	Cloudy all day.
"	15	58	61	62	55	" "
"	16	59	61	61	56	Clear.
"	17	56	62	63	54	"
"	18	62	65	62	54	Clear in forenoon. A little rain towards evening.
"	19	56	62	63	55	Cloudy part of the day.
"	20	56	63	62	58	Clear morning and evening Cloudy at noon.
"	21	59	63	63	55	Clear morning. Sudden haze at dark for a few minutes.
"	22	61	62	64	54	Clear.
"	23	56	64	64	54	Clear in forenoon. Towards evening rain, thunder and lightning.
"	24	55	65	62	53	Clear in forenoon. Cloudy from 3 to 4 P.M.
"	25	59	62	63	55	Clear until evening, then rain.
"	26	60	62	62	53	Cloudy day and rainy evening.
"	27	55	64	65	56	Clear day and cloudy evening.
"	28	60	64	65	57	Clear day.
"	29	61	64	62	55	Clear forenoon. Rain in afternoon.
"	30	59	64	63	58	Hard shower in the afternoon.
"	31	63	65	66	55	Rain in afternoon.
November	1	64	66	63	54	Rain in afternoon and heavy thunder.
"	2	60	64	61	53	Hail large as peas; thunder and lightning all afternoon.
"	3	60	62	63	54	Cloudy; slight rain; a beautiful rainbow; first seen.
"	4	60	62	61	54	Cloudy all day. Heavy shower at 1 P.M.
"	5	58	59	59	51	Cloudy all day; gloomy; rainy all day.
"	6	61	63	62	54	Rain, thunder, lightning, in afternoon.
"	7	59	62	59	51	Clear morning. Rain in afternoon.
"	8	61	63	61	50	Rain in afternoon.
"	9	62	62	61	51	Clear morning. Rain in afternoon.
"	10	58	61	61	49	" " " "
"	11	61	63	62	52	Very little rain during the day.
"	12	61	61	62	48	Gloomy and rainy day. Beautiful and moonlight eve.
"	13	60	61	59	55	Slight rains in the afternoon.
"	14	59	61	59	53	A very hard shower accompanied by loud thunder.

DATED 1858	9 A. M.	12 M	3 P. M	9 P. M.	REMARKS.
November 15	56°	59°	59°	51°	Cloudy all day. Rainy in afternoon.
" 16	61	62	62	52	Pleasant forenoon. Rainy in afternoon.
" 17	60	62	61	55	Rained in the night, a thing unusual.
" 18	62	64	63	53	Beautiful morning. Hard shower at 9 A.M.
" 19	59	62	61	54	Cloudy in the forenoon Rain in afternoon.
" 20	59	61	61	54	Gloomy day accompanied with rain.
" 21	58	60	61	54	Gloomy day ; cloudy ; no rain.
" 22	58	60	60	53	Gloomy day ; cloudy , misty ; no rain.
" 23	59	63	61	54	Sun again seen. Rain in afternoon.
" 24	60	61	62	54	Sun seen again. Shower at noon.
" 25	58	60	61	55	Gloomy day ; a little rain ; clear evening.
" 26	60	62	62	54	Gloomy day ; hard shower in the evening.
" 27	59	60	59	53	Rained all day and night.
" 28	59	62	61	55	Pleasant morning. Hard showers all afternoon.
" 29	60	63	62	55	Clear day.
" 30	60	63	63	55	Hard shower at 9 P.M.
December 1	61	64	63	53	Forenoon pleasant. Showers at 3 P.M.
" 2	59	63	63	55	Cloudy all day ; some rain.
" 3	63	64	63	53	Fine morning. Hard rain all afternoon.
" 4	61	61	62	54	A dismal day ; hard rains.
" 5	61	63	62	53	A dismal day ; some rain.
" 6	59	60	60	53	A dismal day ; constant rains.
" 7	59	60	60	52	A shower about noon ; pleasant afterwards.
" 8	59	60	60	53	Fine forenoon. Heavy showers all afternoon.
" 9	59	63	62	54	A pleasant day.
" 10	60	61	60	52	Rained some.
" 11	60	62	62	53	Fine forenoon. Showers in afternoon.
" 12	62	64	62	53	Pleasant until 3 P.M., then had a heavy thunder storm.
" 13	60	63	63	54	Thunder in afternoon. Rain in evening.
" 14	59	63	62	53	Pleasant forenoon ; stormy afternoon.
" 15	60	63	61	52	Heavy thunder and hail storm about 3 P.M. ; some rain.

December 16	61	63	62	55	Pleasant forenoon ; some rain after.
" 17	60	63	62	55	Some rain forenoon. Beautiful evening.
" 18	60	62	61	54	Hard showers in afternoon.
" 19	61	63	63	55	Clear day ; rain about 9 P.M.
" 20	62	65	64	55	Fine morning. Rain in afternoon.
" 21	61	63	64	56	Fine day.
" 22	61	63	63	57	"
" 23	62	63	63	56	Rain in the afternoon. Fine evening.
" 24	63	65	62	54	Fine morning. Rain most of the afternoon.
" 25	63	65	63	52	Fine morning. Rain towards evening.
" 26	62	63	62	54	Gloomy drizzly, and rainy all day.
" 27	63	64	62	54	A fine morning ; the day ending in rain.
" 28	61	63	63	53	Clear.
" 29	62	64	63	53	Pleasant day ; thunder, but no rain.
" 30	60	62	63	56	Rain about 9 A.M. Afternoon cloudy.
" 31	62	64	63	55	Drizzly rain from 3 P.M. and during the night.
1859.					
January 1	61	64	63	55	Rain from 1 to 3 P.M., afterwards clear.
" 2	59	61	62	55	Rain from 6 to 9 A.M., afterwards clear until 4 P.M.
" 3	62	64	63	50	Constant showers from 4 P.M until dark.
" 4	62	63	62	52	Rain, with sharp lightning and loud thunder from 2 to 5½ P.M.
" 5	61	63	63	52	Clear and beautiful.
" 6	60	62	64	54	Clear except a short time afternoon.
" 7	62	65	66	56	Cloudy afternoon ; Rain began at 8 P.M.
" 8	63	65	62	50	Rain during the afternoon.
" 9	61	60	61	53	Rainy day and evening.
" 10	63	63	63	53	Clear.
" 11	63	64	65	56	"
" 12	63	65	65	53	"
" 13	62	64	63	52	Rain and hail between 3 and 4 P.M.
" 14	62	64	64	55	Cloudy morning. Clear afternoon.
" 15	62	64	64	55	Slight rain towards night.
" 16	62	64	64	55	A few drops of rain about 5 P.M.
" 17	62	64	64	55	" " " "

Dated 1859.		9 A. M.	12 M.	3 P. M.	9 P. M.	Remarks.
January	18	62°	64°	64°	55°	Cloudy day; a little rain towards night.
"	19	61	63	63	57	Some rain last night. Cloudy day.
"	20	62	63	64	53	Clear.
"	21	60	62	63	51	Clear, except morning cloudy.
"	22	62	64	65	51	Hard showers; loud thunder; sharp lightning.
"	23	61	63	63	52	Pleasant forenoon. A little rain in afternoon.
"	24	61	64	63	54	Cloudy morning. Rain set in about dark.
"	25	61	64	64	53	Clear day; rain about 8 P. M.
"	26	62	65	65	54	A little rain about 3 P. M.
"	27	61	64	65	55	Clear.
"	28	63	66	65	56	Clear forenoon. Cloudy afternoon.
"	29	61	64	64	56	Rain during the afternoon.
"	30	62	64	64	56	" "
"	31	61	64	64	54	" "
February	1	61	64	65	58	Cloudy.
"	2	60	62	63	53	Rain in afternoon.
"	3	61	63	64	53	Rain at 3 P. M.
"	4	62	65	63	52	Hail at 1 P. M.
"	5	61	63	64	54	Clear.
"	6	62	63	64	54	"
"	7	61	64	65	59	Clear; rain night.
"	8	62	63	64	54	Cloudy; a little rain in night.
"	9	60	60	61	52	" " "
"	10	61	62	58	53	Rain 1 P. M.
"	11	60	63	63	54	Little rain 1 P. M.
"	12	61	64	64	57	Cloudy afternoon.
"	13	61	64	64	56	Rain between 3 and 4 P. M.
"	14	62	65	64	57	Clear.
"	15	62	65	65	59	"
"	16	62	65	65	58	"
"	17	63	64	63	57	"

February	16	64	66	66	57	Clear.
"	19	64	68	69	57	Slight fall of rain.
"	20	63	65	66	58	Clear.
"	21	64	65	66	57	A little rain about dark. (There is no dusk under the Equator.)
"	22	64	66	66	56	Rainy afternoon.
"	23	64	65	66	56	" "
"	24	64	65	65	56	A little rain afternoon.
"	25	63	65	63	54	At noon commenced hailing, but finally turned to rain.
"	26	62	64	62	54	Rain most of the afternoon.
"	27	61	63	64	58	Clear.
"	28	63	65	66	57	"
March	1	61	63	65	57	Some rain after 4 P.M., and slight one in the morning.
"	2	62	64	63	55	" " " " "
"	3	60	62	63	54	Rain in afternoon and night.
"	4	60	61	61	54	Heavy shower in morning and afternoon.
"	5	60	62	59	49	Rainy day.
"	6	60	61	60	52	Rainy afternoon.
"	7	59	60	60	48	Rainy from 11 A.M. until night.
"	8	59	62	64	54	No rain until after 4 P.M.
"	9	61	63	63	57	" " "
"	10	62	63	66	55	" " "
"	11	60	63	62	57	" " " *Earthquake shock at 8 A.M.*
"	12	61	64	64	54	" " "
"	13	62	64	65	56	" " "
"	14	61	63	64	55	Clear.
"	15	62	64	66	59	"
"	16	61	63	64	56	Rain in afternoon.
"	17	63	65	65	57	" "
"	18	61	63	62	56	" "
"	19	59	61	60	55	" "
"	20	59	64	60	56	Hail and rain in afternoon.
"	21	59	62	60	55	Rain after 2 P.M.
"	22	59	62	62	57	Rain after dark. *Heavy earthquake shock at 8½ A.M.**
"	23	58	62	62	56	Rain after 4 P.M.

*For note see page 684.

Dated 1859.		9 A. M.	12 M.	3 P. M.	9 P. M.	Remarks.
March	24	60°	65°	64°	59°	Very little rain afternoon.
"	25	61	62	63	55	" "
"	26	58	61	63	54	Rain most all day.
"	27	59	60	60	55	" "
"	28	59	61	61	54	" "
"	29	59	62	59	53	" "
"	30	57	58	58	54	" "
"	31	57	58	57	53	" "
April	1	54	56	56	52	" "
"	2	59	58	57	51	Clear morning. Rain and hail from noon until 4 P.M.; then clear.
"	3	56	58	57	53	Rain from noon till night.
"	4	56	58	57	53	Rainy.
"	5	56	56	56	53	"
"	6	58	58	57	54	Clear until noon, after which, rain.
"	7	58	59	59	53	A little rain about 4 P.M.
"	8	56	59	59	54	Clear forenoon. Cloudy afternoon.
"	9	58	61	61	56	Some rain between 4 P.M. and dark.
"	10	58	60	60	55	" " " and at 9 P.M.
"	11	59	62	60	56	Rain in evening.
"	12	59	60	62	55	Clear.
"	13	58	59	59	54	"
"	14	58	61	61	55	A little rain at noon.
"	15	59	61	61	54	Clear.
"	16	59	63	61	55	"
"	17	60	63	61	54	"
"	18	60	63	63	55	A little rain about noon. Rained hard at 9 P.M.
"	19	61	62	60	53	A little rain about noon
"	20	59	62	63	57	Clear.
"	21	61	61	63	54	"
"	22	61	62	64	53	"

April	23	61	63	64	58	Cloudy.
"	24	59	61	61	56	A little rain about noon.
"	25	61	62	61	55	A hard shower a little after noon.
"	26	59	62	58	53	Cloudy afternoon and a little rain.
"	27	60	62	62	55	Rain and clouds most of the day.
"	28	60	63	62	56	Rain at noon and at 3 P.M.
"	29	60	63	60	55	Rain about 2 P.M.
"	30	60	61	61	54	Lightning, thunder and rain.
May	1	59	58	57	51	Rainy.
"	2	58	62	63	58	Clear.
"	3	59	59	58	53	Rainy.
"	4	59	60	60	58	"
"	5	60	62	61	53	Some rain in afternoon, with hail.
"	6	59	62	60	58	Rain, hail, thunder and lightning during afternoon.
"	7	59	62	61	54	A little rain about 4 P.M.
"	8	58	63	61	54	Cloudy and windy afternoon ; thick fog between 7 and 8 P.M.
"	9	54	57	58	48	Rainy, but clear evening.
"	10	58	60	61	51	Hard showers with rain after 3 P.M.
"	11	58	62	60	51	Lightning, thunder and rain during afternoon.
"	12	58	62	60	52	Cloudy afternoon ; a little rain about sunset.
"	13	57	59	59	51	A drizzling rain all day.
"	14	57	59	58	52	A cloudy day ; rainy afternoon and evening.
"	15	57	59	58	54	Rain afternoon and night.
"	16	57	58	58	51	Rainy day and night.
"	17	56	57	57	51	Rainy afternoon.
"	18	56	59	58	52	Cloudy day ; rain after 4 P.M.
"	19	55	55	56	54	Rainy afternoon. *Heavy earthquake shock after 3½ A.M.*
"	20	56	58	57	51	Cloudy and windy ; rain in afternoon.
"	21	55	56	56	58	Cloudy.
"	22	55	59	59	54	Clear.
"	23	56	61	60	54	Cloudy and windy ; in afternoon thunder and lightning.
"	24	56	58	58	50	Clear ; windy afternoon for Quito.
"	25	56	59	60	49	Clear.
"	26	56	59	61	51	"

Dated 1859.		9 A. M.	12 M.	3 P. M.	9 P. M.	Remarks.
May	27	56°	60°	62°	49°	Clear.
"	28	56	61	62	53	"
"	29	58	62	61	50	"
"	30	58	61	62	56	"
"	31	60	65	65	56	"
June	1	59	65	63	56	"
"	2	60	64	65	56	" considerable wind.
"	3	60	63	64	56	"
"	4	60	64	65	54	"
"	5	60	64	64	54	"
"	6	60	64	64	56	" and windy.
"	7	61	64	65	55	" " about noon.
"	8	60	62	65	55	"
"	9	60	64	65	55	"
"	10	61	63	63	56	"
"	11	61	64	63	56	Some clouds ; rain after 4 P. M.
"	12	61	63	62	56	Clear until noon, then a shower.
"	13	61	63	63	57	Floating clouds all day.
"	14	61	63	64	53	Clear.
"	15	61	64	64	54	"
"	16	61	64	64	54	"
"	17	61	64	64	53	"
"	18	59	64	64	53	"

* On the 22d of March was one of the heaviest earthquakes that ever occurred in Ecuador, not only as to loss of life, but as to surface transformations. It may be noted that the temperature was comparatively unchanged.—C. B. B.

Stated Meeting, October 3, 1884.

Present, 7 members.

Mr. INGHAM in the Chair.

Letters of acknowledgment were received from McGill University (114) and J. H. C. Coffin (115).

Donations to the Library were received from the Department of Mines at Melbourne; the Geological Survey of India; the Imperial Society of Naturalists, at Moscow; the Venetian Athenæum; Baron Ferd. von Mueller; Revue Politique; London Nature; the Philosophical and Literary Society at Leeds; the Alchemist of Montreal; the Boston Society of Natural History; the American Journal of Science; Mr. B. Silliman; the Connecticut Academy of Sciences; the Meteorological Observatory at New York; the Academy of Natural Sciences at Philadelphia; Mr. Henry Phillips, Jr.; the United States Geological Survey, the United States Fish Commission; the American Antiquarian; and Mr. J. B. Stallo.

Mr. J. Sutton Wall, of Monongahela City, Pa., exhibited a canvas tracing of a group of Indian pictures cut on the top and sides of a half-buried block of sandstone perched on the bluff of the Monongahela valley, in Fayette county, Pa., opposite Millsborough, at a height of 290 feet above the river. A photograph of the canvas was exhibited.

Also a photograph of a tracing of similar figures on the rock shore of the river near Geneva, now submerged by a new slackwater dam.

Also one of a carved rock on the Hamilton farm near the Evansville turnpike, six miles south-east from Morgantown, in West Virginia. This rock surface is vertical.

In answer to a question respecting the safety of such monuments, Mr. Wall replied that a fourth fine group, of which he had heard, was destroyed before he could obtain a tracing of it, the farmer who owned the land having blasted it up for foundation stone for his new house; and that the owner of the

large group on the canvas informed him of his intention to treat the perched rock in the same way, when he built his new barn.

On motion of Mr. Phillips, it was

Resolved, That the subject be referred to the consideration of the Board of Officers and Council at its next meeting, whether any steps can be taken by the Society to pieserve such monuments from destruction.

Mr. Lesley read a Note on a possible origin of the Pshent.

Mr. E. B. Harden exhibited, through the Secretary, a square pipe of limonite, which had been deposited against the inside walls of a vertical wooden box, leading down to the sump of the Eagle shaft near Pottsville, Pa. The outside layer, first deposited, was a beautifully perfect fac-simile of the inside rough face of the boards, showing the grain, saw cuts, and knots in the wood. The whole specimen admirably illustrated the formation of selvage veins.*

Dr. Syle presented a copy of the Chinese translation of Herschel's Outlines of Astronomy, in three volumes, published at Shanghai, December, 1859.

Pending nominations Nos. 1029, 1030 were read.

The Kansas Academy of Science at Topeka was ordered to be placed on the list of corresponding societies for exchange of publications.

The request of the Journal of Associate Engineering Societies, Washington University, St. Louis, Mo. (Sept. 27), was referred to the Secretaries.

An appropriation was made for publishing a plate illustration for the Proceedings, No. 117.

The Hall Committee was authorized to prepare the north garrets for the reception of the stock of publications.

And the meeting adjourned.

* This specimen was analyzed by F. E. Bachman, Chemist of the Phœnix Iron Co., and found to consist of 76.17 per cent sesquioxide of iron. The residue contained very little silica.


PICTURE ROCK.
On Hamilton Farm, near the Evansville Pike,
WEST VIRGINIA.
J. SUTTON WALL
B. F. BENTLEY

PICTURE ROCK,

On the shore of the

MONONGAHELA RIVER,

NEAR GENEVA FAYETTE COUNTY, PA.

BY

J. SUTTON WALL

AND

WILLIAM ARISON.

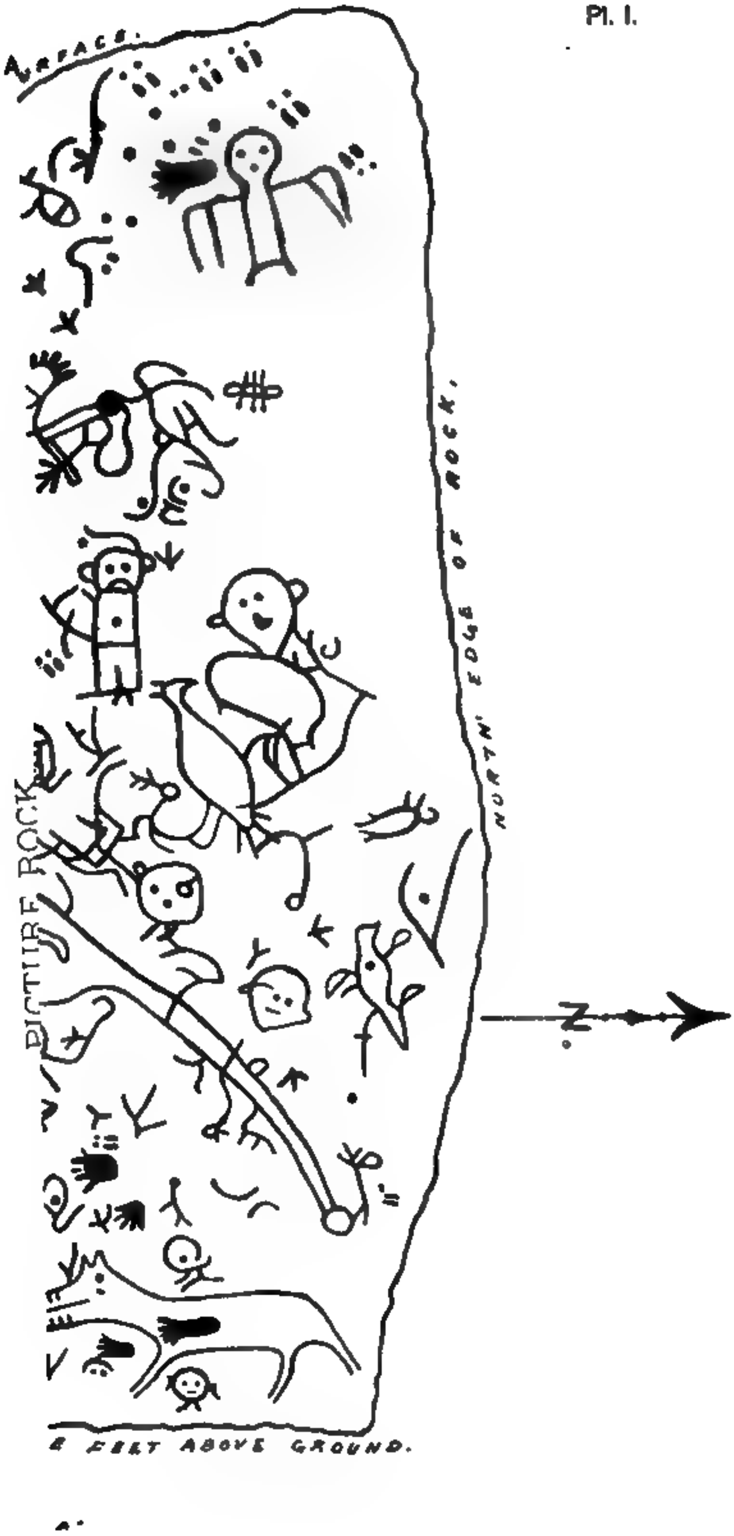
PHOTOGRAPH FROM TRACING ON MUSLIN.

OCTOBER, [illegible]

Soc. Oct. 1884.


EVEN WITH GROUND
ROCK THRE
AST E

Pl. I.



On some Indian picture rocks in Fayette County, Pa. By Mr. J. Sutton Wall.

(Read before the American Philosophical Society, Oct. 3, 1884.)

The tracing on muslin (Plate I.), exhibited this evening, was made by Mr. William Arison, of Monongahela City, and myself, in the month of September, 1882.

This rock is perched on the crest of the hill facing the Monongahela river, opposite the town of Millsborough, at an elevation of 290 feet (by barometer) above water level of the river. It is a detached portion of the Waynesburgh sandstone which outcrops in the vicinity. Rather coarse in texture, it has a fairly even and smooth top surface, and is approximately sixteen feet square, with perpendicular sides. The top of the hill, next to the river, terminates rather sharply, and the ground surface receding from the river has a gradual fall of about ten feet per hundred for a distance of perhaps eighty yards, and then rises into a more elevated hill to the eastward of the rock. The rock occupies a position from which a very fine view of the river and Ten Mile valley can be had. The edge of the rock next to the river rests about even with the ground surface surrounding it, while the opposite edge rests about three feet above ground. It is not fissile and the top surface would be difficult to remove. The outlines of the figures are formed by grooves on channels smoothly and regularly cut or incised in the top surface and on two sides, of the width shown on the tracing, and are from three-fourths of an inch to a mere trace in depth. The foot-prints and cup-shaped cavities are carved about the same depth, except the large circular disc, which also is a cupped-shaped cavity, about five inches in depth. There are the outlines of two animals carved on the sides, one on the south side, which is shown on the tracing, and the other on the east side, not shown.

The figure composed of three connected links, with three lines or perhaps arrows drawn across them, I am inclined to place to the credit of vandalism, which is still in rapid progress, and will ultimately destroy the original carvings. Some of the lines are becoming quite faint, owing no doubt to erosion by the atmosphere. We only traced those lines and portions of lines that were distinctly legible.

Mr. Joseph Horner, and old resident of Millsborough, informs me that the figures were much more distinct, when he first saw them fifty years ago, than at the present time. A tradition exists in the neighborhood that the early settlers were informed by the Indians, that they had no knowledge of the authors of the carvings, but that they found them as the "white men" then saw them. The tracing shows all the figures reversed, but by looking through the canvas from the other side you can see them in their true position, which may be done by placing lights behind it. The tracing was made by painting the grooves and indentations with a mixture of lamp-black and turpentine, and then spreading strips of muslin over the portions painted, and by using a brush and our fingers,

the lines were transferred to the muslin ; after which it was sewed together in proper connection, and the lines made more permanent by repainting with diluted printers' ink. Mr. E. B. Harden, of the State Geological Survey, recently photographed a small portion of the top surface of the rock ; but was unable to obtain a proper position for photographing the whole surface. To do this properly an elevated position would be necessary at some distance from the rock. This could be done by the aid of a small amount of lumber and tools, which we did not have at hand at the time of our visit.

Plate 2 is a reduction from a tracing on muslin (natural size), showing the figures carved on the surface of a rock located on the east shore of the Monongahela river, a half mile below Geneva, in Fayette county, Pennsylvania. The rock has a fairly even and smooth upper surface, falling slightly toward the water, and is an eroded portion of the Morgantown sandstone in place. A portion of this rock containing figures was removed some years since, and used in constructing a building in Geneva. The figures thus removed I did not see.

The execution of the carvings appears to be of the same character as that on the rock shown by Plate 1. The marked resemblance of many of the figures leads me to consider it of the same age and origin as the other carved rocks in this region. At the time of my visit, in 1881, the upper portion of the rock rested only about four feet above low water, and I have since learned that the portion containing the figures copied has been rendered inaccessible by the back water, formed in the pool from the construction of Lock and Dam, No. 7, at a point nearly two miles farther down the river.

Plate 3 is also a reduction from a tracing of a carved rock located in West Virginia, near the north side of the Evansville pike, six miles southeast of Morgantown. This is along the crest of an elevated ridge, commanding a fine view of the surrounding country. The ridge on either side of this pike is strewn with numerous large blocks of sandstone, evidently detached from their native bed, and many of them present excellent surfaces for carving. But I only found two of them to contain any figures, out of a large number which I examined in the vicinity.

The figures shown on this plate were all found on one rock, and are represented in their true position. They are incised or cut in the top suface, evidently in the same manner as the rocks already mentioned. The small pot-shaped holes, buffalo and bear tracks form a common feature of all these pictured rocks. Each individual rock is however usually found to contain some figures not shown on others. Slight variations are also noticeable in the manner of representing certain animals and reptiles ; as for instance difference in posture. The rattlesnake is distinguishable by the line or bar which marks the termination of the body proper and shows the beginning of the rattles. The semi-circular figure on the left side of the plate forms, in my judgment, an interesting feature of this rock. It strikes me that this figure has been intended to represent a horse's track or foot-

print. If this interpretation be a correct one, it goes toward fixing the age of the workmanship, and brings it within the historic period of North America.

Stated Meeting, October 17, 1884.

Present, 15 members.

President, Mr. FRALEY, in the Chair.

A letter requesting exchanges was received from Mr. J. C. Rowell, Librarian of the University of California, dated Berkeley, October 1. On motion, the University of California was placed on the list to receive the Transactions and Proceedings from the beginning.

A letter requesting missing numbers of Transactions and Proceedings American Philosophical Society was received from the Imperial Society of Nature, Moscow, dated September 1.

Donations to the Library were reported from the Royal Society of Victoria; the Annales des Mines and Revue Politique; the Royal Academy of History at Madrid; the Meteorological Office, the Journal of Foresty and London Nature; Dr. Edward Jarvis, of Boston; Harvard University; the New York Academy of Sciences; the College of Pharmacy, the Franklin Institute, the Engineers' Club, the American Journal of Medical Sciences, Rev. E. W. Syle, Mr. Henry Phillips, Jr., and L. R. Hamersly, of Philadelphia; the Maryland Historical Society; the Bureau of Education, the United States National Museum and the Surgeon-General's Office at Washington.

A paper on *Herderite* was read by Dr. F. A. Genth.

A paper on the Language and Ethnographic position of the Xinka (Shinka) Indians of Guatemala was read by Dr. D. G. Brinton. The paper embraced two vocabularies of three dialects, the only known existing specimens of the language.

Dr. Syle objected to the statement made in the memoir that the absence of native names of *salt*, *maize*, &c., must necessarily be taken as evidence that the aboriginal Xinkas did not know, or possess the articles until the advent of their Aztec and Maya conquerors; adducing the fact that the

Japanese now use many Chinese names for things which they had before, and for which they had and still have their own names.

Mr. Phillips instanced the adoption of the word "alcohol" by the English, and their abandonment of "spirits of wine."

Dr. Brinton replied that the evidence was made stronger by the foreign words being repeated in all three dialects; and that comparative philologists recognize the rule as a good one, and the inference as reasonable, that if the Xinka vocabularies have no native word for hat, and have instead the Spanish word *sombrero*, the hat was probably not an article of native dress.

Mr. Ashburner described observations at the Luray caverns, and at the Natural Bridge, in Virginia, which he had made recently.

He found by barometric and by direct measurements that the traditionary data of the French Engineers were exaggerated. Instead of 215′, he made the crown of the arch 185′ and 187′ above the stream. Instead of the popularly received 2000′ above tide, his connections with the nearest railway station made the stream 915′, and the crown of the arch 1102′ A. T., and the Hotel 1040′. The thickness of the bridge at the north side is 46′; at the south side 36′.

Cedar creek flows beneath the bridge *southward*. The rock of the bridge is nearly horizontal. The rocks north of the bridge dip steeply towards it (*i. e.*, downstream, southward); those south of the bridge dip perceptibly also towards it (*i. e.*, upstream, northward). There is, therefore, a local synclinal at the bridge; and Mr. Ashburner would thus account for the existence of the bridge at that particular point. The last remnant of the roof of a long cavern, following a special stratum across a synclinal, would necessarily be left precisely in the axial line of the trough.

The Luray cavern ramifies to great distances, but always in a particular group of limestone beds, limited to 65 feet. The cavern of the Natural Bridge must have been limited to a certain soluble horizon of the formation. Its great height now is no safe index of the height of the cavern formerly; nor of the width of the soluble rock zone; but is to be ascribed to the vertical erosion of its channel by Cedar creek, in adjusting its water slope to the neighboring open lower country.

Dr. Frazer remarked that when he visited the Bridge three years ago he noticed steep (45° ±) dips further south; and therefore that the synclinal must be very local.

Dr. Frazer desired to place on record his dissent from Prof. H. C. Lewis's paper on a great trap range through Southern Pennsylvania, read at the late meeting of the American Association for the Advancement of Science; because the discussion which followed the reading of that paper would not appear in the volume of the Transactions of the Association.

Trap Dykes in the Archæan Rocks of Southeastern Pennsylvania.
By Dr. Persifor Frazer.

(Read before the American Philosophical Society, October 17, 1884.)

Among the geological papers announced to be read in Section E of the late meeting of the American Association for the Advancement of Science, in Philadelphia, was one by Prof. Henry Carvill Lewis on a Trap dyke in Eastern Pennsylvania. It describes a dyke which (its author asserted) had been overlooked by the speaker and other geologists in this portion of the State, and which was distinguished, both by its great length and by certain peculiarities of position,* from other dykes in Pennsylvania.

This faulted dyke is supposed to have been laterally thrown for a distance that was understood to be five miles as Prof. Lewis described it. But on hearing that the "hade" or dips were nearly vertical in both parts which it was thought were once in contact, Prof. James Geikie thought that any previous continuity of the two dykes must be abandoned.†

In describing the course of his dyke, Prof. Lewis remarked, "Dr. Frazer failed to trace it through Chester county, though he has a small portion of it on his geological map in Easttown township; nevertheless I have followed it over the surface, foot by foot, by the loose boulders on the surface; and found it to be continuous," or words to this effect.

There happened to be on the wall the joined maps of the four counties which the speaker had prepared for the Second Geological Survey, viz: Adams, York, Lancaster and Chester, and he referred to them as follows:‡

The great amount of disintegration of the surface rocks of Chester county has caused a deep soil, which overlies a large portion of the rocks of the county on the line of this dyke, and the constant movement of this soil renders it very difficult to trace the buried outcrops by loose boulders and fragments. The consequence of this is that if one maps all the localities where masses of trap are found, and attempts to connect them by lines, the irregularity of the latter will inform him that he is probably not representing the facts of structure as they exist. In Adams county, where the decomposition is generally much less profound than in Chester, in the

* The text of this paper is not at hand and the writer must trust his memory for its contents. It is very unfortunate that in the reports of the proceedings of Sections of the A. A. A. S., there should be no account taken of the discussions on papers; especially in cases where statements are observed and pointed out which seem to be at variance with a cautious judgment of the facts. The disadvantage of this state of things to the cause to which the Association is nominally devoted is still further increased by the long period which must elapse before a paper finds its way into print. Error is notoriously fleet of foot, and with a year's start may defy pursuit.

† In a rather exceptionally full notice of this paper (omitting however mention of the objections to it) given in *Science* subsequently, the fault is stated to be several thousand feet, but the extent of the lateral displacement is mentioned only as "large."

‡ The following remarks are quoted from memory and somewhat amplified.

region of the dykes, a great deal of work was necessary before the seemingly capricious outcrops could be brought into anything like order. Let any one look at the regularity of the three threads of trap passing from N. E. to S. W. on the map of Adams county of the First Geological Survey, and compare it with the irregular and broken lines of the trap in the map of the same county by the present Survey, and he will find a case in point.

It will not suffice to find three or four occurrences of fragments of trap, lying more or less in a straight line, in a distance of a mile or more, in order to assume a dyke of trap connecting them under the soil.

On looking over the maps of the townships south of the Chester valley, which the speaker carried into the field when engaged in the Geological Survey, he remarks in a great many places notes of trap fragments on the surface. But with some experience in tracing the outcrop of this rock, he did not feel justified in connecting these isolated indications together, and he still doubts whether this should be done. The absence of a map of the dyke prevents him from saying how many of these occurrences are included within the dyke mentioned by Prof. Lewis, but no single dyke can include many of them.

It is a very different matter if it is merely claimed that this supposed new dyke indicates the direction of a zone or belt of disturbance along which two, twenty, or fifty outbursts of igneous rock may have taken place, just as it is shown that in north-western York and central Adams counties, notwithstanding all the irregularity of the outcrops, there is a general zone along which the main outflows have taken place.

The considerations which the speaker has so often urged in connection with this region, make the existence of such a belt exceedingly probable. (See Mémoire sur la partie S. E. de la Pennsylvanie, pp. 90, 109+, etc.) It has been abundantly urged, both in this memoire and elsewhere, that the exceedingly straight southern limit of the Chester valley implies other causes at work than those of ordinary deposition: in other words, a great longitudinal crack along the southern side of which the lower measures were brought up; that this great crack would in all probability be connected with others crossing or diverging from it hardly needs to be stated; but if the speaker was unable to represent this line of fracture by a single well defined dyke, there are abundant allusions both to outflows of trap and to the existence of a belt of dislocation, as the following from C_4* will show, p. 286. "The trap dyke, traceable only by its broken fragments† on the surface, which has been alluded to as occupying the southern edge of *Tredyffrin* township, enters *Easttown*," etc. (here follows a detailed statement of its course), * * * "when its traces cease to be apparent, though a few scattering boulders and fragments of trap are met with."‡

*Geology of Chester county, Persifor Frazer, edited by J. P. Lesley.

†Of course, a trap dyke may be assumed when the whole ground is made up of the larger or smaller fragments, but the question how many trap fragments will enable one to assume the presence of a dyke is, like many others, not capable of a general answer.

‡The trap here referred to is part of the "great dyke" which forms the subject of the paper above alluded to.

In the succeeding township, *Willistown*, it is stated of the rocks: "* * * Southernmost of all, a broad band of syenitic granite and hornblendic gneiss, in which latter are dykes of dolerite (as near Lukens'), and another band of serpentine. How would these facts agree with the hypothesis hinted at above, that the lower Primal was represented by the pseudo-quartz porphyry and feldspar porphyry; that this was overlain by the quartzite proper; this by schists, and this by limestone; that there had been first a synclinal valley of all these, and finally a break in or on the side of the valley, by means of which the lower measures had been thrown up on the south and planed off evenly," etc.

Under *West Goshen* township "fragments of dolerite are frequent, but no *dyke* was apparent." In the description of *West Marlborough* township, "Syenite apparently belonged to a dyke, of which the exact position was not determined," is noticed south of Doe run, and "loose pieces of dolerite were deemed insufficient to warrant the placing of this formation on the colored map" (p. 307). In the description of *East Nottingham*, fragments of syenite are mentioned, &c., &c. (p. 343).

In addition to the above references in the text of C_4 to trap, there are marks in the following localities on township maps used in the field by the speaker, which indicate the presence of igneous rock fragments which were not placed upon the county map because not sufficiently indicative of the position of the parent dyke: *East Goshen*, N.E., N. and N.W. of Goshenville; *West Goshen*, near water works; *East Bradford*, near Copesville; *East Marlborough*, near Unionville; *West Marlborough*, S.W. and N.W. of Upland, near and W. of Woodville, etc.; *Lower Oxford*, near Lincoln University, etc.; *Easttown; Willistown*, near White House P.O., N. and N.W. of Sugartown; *Highland*, near Gum Tree and near Fairview School House; *Kennett; New Gardon*, near Toughkenamon, etc.

It is not pretended that these citations cover all the places where trap was found, but they will serve to indicate that in the opinion of some field workers, there is a long step to be taken from the occurrence of a number of trap fragments on the surface to the establishment of a dyke in place.

Prof. Lewis concluded his description by saying, that such a dyke would form an important feature in the geology of the State. In this the speaker agreed with him, though whether or not the line of the trap be as continuous as he has represented it, the belt of disturbance had been established long ago.

But this dyke, if established, would be singularly confirmatory of the long fault and southern upthrow, which constitute the kernel of the speaker's hypothesis of the structure of the rocks in Southeastern Pennsylvania: for, that there should be a fracture filled with injected rock, following just the course which the speaker has ever maintained the fault to occupy, for "ninety miles;" and that the upthrow in one place (not in Chester county) was, "several thousand feet," in extent, would be clearly corroboratory of the speaker's view.

The position of this belt is indicated, C_4 (*l. ci.*), as follows: * * * "These slates are bordered by a great belt of serpentine, of which the northern boundary is nearly parallel with the southern margin of the limestone itself, as if the mass of schists intervening had about a uniform thickness, and that the serpentine were a true contact formation occurring between these schists and the lower rocks."

Attention was drawn to another statement of Prof. Lewis, viz: that the lithological characteristics of this dyke were constant throughout its range. This was entirely at variance with the speaker's observation. There were strongly marked differences of texture, structure, and constitution between many of these outcrops in the townships south of the Chester valley, and near Conshohocken.

On Herderite. By F. A. Genth.

(*Read before the American Philosophical Society, October 17, 1884.*)

In the American Journal of Science [3], xxvii, 135–138, in an article on Herderite, by William Earl Hidden and James B. Mackintosh, the latter published his analysis of this rare mineral from Stoneham, Me. In a letter to the editors of the "Neue Jahrbuch der Mineralogie, &c.," of 1884, ii, 134–136, Professor A. Weisbach gives the results of a comparative examination of the *original* herderite from Ehrenfriedersdorf, Saxony, and of that of Stoneham, Me., made at his suggestion by Dr. Cl. Winkler.

These investigations, showing remarkable discrepancies not only between Dr. Winkler's analyses of the herderite from the two localities, but also between those of the two analysts of the Stoneham mineral, it was desirable to re-examine this interesting species.

I am under great obligations to Mr. George F. Kunz, who has kindly furnished me with the material for this investigation, from which I was able to pick out over 2.5 grms. of pure crystals.

Referring to the occurrence of herderite, he has sent me the following communication, dated New York, October 14th, 1884:

"On revisiting the Stoneham locality I found that the herderite had all been "obtained from a vein of margarodite, four feet wide, about twenty feet long, "worked to a depth of ten feet. This vein is on the side of the top of Harndon "hill, about one hundred feet from the place where was found the topaz obtained "by me (see Proceedings New York Academy of Science, November and De- "cember, 1882, and American Journal of Science, Feb., 1883), and not in the same "pocket, as stated in the article, in the American Journal of Science, Jan. 7, "1884. The vein is almost entirely margarodite, occurring here in unexampled "crystals. These at times cover spaces four or five inches square with distinct "perfect crystals of margarodite, also altering to serpentine, and associated "with it what is possibly topaz, altered into serpentine.

"The herderite occurs almost invariably in crystals, implanted on the mar- "garodite, crystals of quartz, and in a few instances on columbite.

"Between the herderite vein and the topaz vein worked by me were found the "large columbite and triplite. Two distinct crystals of triplite have been found "recently.

"Signed, GEORGE F. KUNZ."

The analysis of herderite presents great difficulties, and the following methods have been used in the different analyses:

I. A portion of the material was slightly yellowish, and probably contaminated with a trace of mica. 1.0334 grm. were slowly ignited to a bright red heat in a well covered platinum crucible, and lost 4.80 per cent; after ignition, the lid and outside margin of the crucible were found coated with a film, which, when moistened with water, gave a strongly acid reaction.

About equal weights of silica and the mineral were fused with about six parts of sodium carbonate for one hour. The well-fused mass, which was greenish from a minute quantity of manganese, was lixiviated with water and should now have contained *all* the phosphoric acid, and fluorine. The silica in the solution was precipitated by ammonium carbonate, and from its filtrate the remaining silica by zinc oxide, dissolved in ammonium carbonate and ammonia. From the filtrate of the zinc silicate after evaporation to dryness and dissolving in water, the greater portion of the sodium carbonate was neutralized with dilute nitric acid, then precipitated with silver nitrate, keeping the liquid slightly alkaline. In the filtrate the balance of the fluorine (which had not been expelled by ignition), was precipitated together with calcium carbonate by calcium chloride. The mixed precipitate was ignited, dissolved in acetic acid, evaporated to dryness, the calcium acetate dissolved out by water and the calcium fluoride determined. It gave 1.57 per cent which would give, with that driven off by ignition, about 6.4 per cent.

The zinc silicate precipitate was found to contain phosphoric acid.

The portion insoluble in water was dissolved in a little hydrochloric acid and the clear solution precipitated by ammonia, and this separation twice repeated, and washed, until the filtrate was free from lime. The precipitate was ignited and weighed. It gave over 37 per cent and contained a large quantity of phosphoric acid. It was then re-dissolved in hydrochloric acid, the excess driven off by evaporation, then dissolved in water and enough sodium hydrate added to re-dissolve the greater portion of the precipitate. From the filtrate of the insoluble portion the phosphoric acid was precipitated by baryum hydrate as baryum phosphate; in the filtrate from this the excess of baryum was removed by sulphuric acid, and from the filtrate of the baryum sulphate, the glucina and alumina were precipitated with ammonia. The residue insoluble in sodium hydrate contained about 4.5 per cent of lime, nearly 3 per cent of phosphoric acid, a little iron and glucina and alumina, which latter were added to the ammonia precipitate.

These were then re-dissolved in as little acid as possible, precipitated by ammonia, and the separation of glucina from alumina attempted by that method, recommended by the highest authorities as the most perfect, namely, boiling these hydrates with a concentrated solution of ammonium chloride. The strength of the solution was kept so, that on

cooling a small quantity of ammonium chloride crystallized out. It was boiled briskly for a whole day, and did not show any bumbing at all; a large insoluble residue remained. It had a slightly yellowish color from a little iron, but had not the slimy gelatinous appearance which alumina would have presented, but, on the contrary, it was, without being crystalline, more granular and resembled beryllium hydrate precipitated on boiling from a dilute solution in sodium hydrate. The filtrate was precipitated with ammonia and gave 5.61 per cent of ignited beryllium oxide. That portion insoluble in ammonium chloride dissolved readily in a minute quantity of dilute hydrochloric acid. Sodium hydrate was now added and the whole evaporated in a platinum dish to a pasty consistency, then diluted with cold water and the little ferric hydrate filtered off, which was subsequently dissolved in hydrochloric acid, precipitated by ammonia. In washing the iron precipitate the filtrate became gradually more and more turbid. It was still more diluted with water and boiled for about one hour, when it was filtered off and washed; it gave 8,99 per cent.* The filtrate was now acidulated with hydrochloric acid and precipitated by ammonia and gave 0.17 per cent of alumina, which was dissolved in hydrochloric acid and precipitated by ammonia and was found to be insoluble in ammonium carbonate.

The different constituents were added together and gave the results given below. A considerable quantity of phosphoric acid was lost probably in the zinc silicate before I was aware of the fact that this retained such a large portion of it, and only 41.76 per cent were obtained.

II. 0.8608 grm. of finely powdered perfect crystals, dried over one week over sulphuric acid, were fused with twice their weight of silica and sodium carbonate, and the mass treated as in I. It was found, however, that for this mineral this method, even with such an excess of silica, cannot be used advantageously, as the phosphoric acid, notwithstanding the most careful operations, was contaminating almost every precipitate and was largely contained in the zinc silicate. After the greater portion of the phosphoric acid was obtained, there was still about 4.5 per cent with the glucina and ferric oxide, from which it was separated by ammonium

* This unexpected behavior of glucina with a boiling solution of ammonium chloride induced me to make the following experiments: A quantity of beryllium carbonate, prepared from beryl, from Acworth, N. H., was dissolved in hydrochloric acid, to the strongly acid solution ammonia was added until it showed a slightly alkaline reaction. It was boiled briskly for one day, then filtered, the undissolved residue was again dissolved in an excess of hydrochloric acid, precipitated by ammonia and boiled for another day and filtered. The two filtrates were mixed and precipitated by ammonia and gave 0.1158 grm. of beryllium oxide. The insoluble residue was dissolved in just enough hydrochloric acid precipitated and redissolved by sodium hydrate, diluted with much water and boiled for one hour. The precipitate weighed after ignition 0.1424 grms. Both were converted into anhydrous sulphates, the first furnishing 0.4742 grm. containing SO_3 = 75.58 and BeO = 24.42; the second gave 0.5912 grm. sulphate of beryllium with SO_3 = 75.95 and BeO = 24.05.

molybdate. The excess of molybdic acid was removed by precipitating the slightly acid solution by nitrate of lead. The excess of lead and trace of molybdenum were precipitated by hydrogen sulphide, and from the filtrate the glucina, ferric oxide and alumina separated by sodium hydrate as in I. I am afraid that a portion of the fluorine was lost in a similar way. The ignited calcium fluoride was treated with sulphuric acid and weighed as calcium sulphate, and, as probably a little silica was there which was volatilized as silicon tetrafluoride, it lost 1 per cent, and gave only 6.04 per cent of fluorine.

III. 0.3303 grm. of the same material as I, was intimately mixed with a known quantity of freshly ignited plumbic oxide, and put in a small platinum crucible with close cover, this was placed in a larger platinum crucible which had some magnesia in the bottom, it was then tightly covered and gradually heated to a strong red heat, which was continued for twenty minutes. After cooling the small crucible had sustained a loss of 0.0020 grm., which would represent 0.61 per cent. The contents of the crucible were completely fused and the lid showed a slight film. As lead fluoride is slightly volatile, it is a question whether this very small loss may not be owing to this, and that the mineral is anhydrous.

The fused mass was dissolved in acetic acid and filtered, the residue, consisting mostly of lead phosphate and fluoride, was dissolved in diluted nitric acid. A pulverulent residue, containing amongst other substances calcium fluoride, was filtered off, the fluorine driven off by sulphuric acid and the sulphates added to the other portion of the analysis. It was found that a considerable portion of the lead phosphate had gone in solution, therefore all the liquids, from which the lead had been removed by hydrogen sulphide, were united and the analysis finished as under II.

IV. 0.5860 grm. of the very finely powered perfect crystals from another specimen with traces of albite was placed in a platinum crucible moistened with water, and then sulphuric acid was added and it was evaporated until copious fumes of sulphuric acid went off. It was dissolved in water and hydrochloric acid. A very slight portion, 0.0070 grm., escaped the decomposition and was therefore deducted from the original quantity. The solution was precipitated by ammonia which would precipitate all the glucina, alumina, ferric oxide and a part of the lime in combination, with all the phosphoric acid, and would leave the calcium which was in combination with the flourine in solution. I found that 18.16 per cent had not been precipitated, which corresponds to 8.93 per cent of fluorine, which is probably more correct than 6.04 per cent as found by direct determination. The precipitate by ammonia was dissolved in nitric acid, the phosphoric acid precipitated by ammonium molybdate and the analysis finished as above.

To my four analyses I add for comparison those of Mr. Mackintosh and Dr. Winkler.

	Stoneham.						Ehren-friedersdorf.
	I	II	III	IV	Mackintosh.	Winkler.	Winkler.
P_2O_5 =	41.76 —	43.01 —	43.38 —	43.43 —	44.31 —	41.51 —	42.44
BeO =	14.60 —	15.01 —	15.17 —	15.04 —	15.76 —	14.84 —	8.61
Al_2O_3 =	0.17 —	0.22 —	0.09 —	0.20 —	—— —	2.26 —	6.58
Fe_2O_3 =	0.48 —	0.31 —	0.49 —	0.15 —	—— —	1.18 —	1.77
MnO =	0.09 —	0.08 —	0.12 —	0.11 —	—— —	—— —	——
CaO =	33.96 —	34.06 —	33.74 —	33.65 —	33.21 —	33.67 —	34.06
H_2O =	—— —	—— —	?0.61 —	?0.61 —	—— —	6.59 —	6.54
Fl =	—— —	?6.04 —	—— —	8.93	11.32		
				102.12	104.06		
Less O =				3.76	4.76		
				98.86	99.84		

Silicic acid and the alkalies belonging to the albite, etc., have not been determined, it should be remembered however that 0.20 alumina represents one per cent of albite.

The analysis made by Mr. Mackintosh and myself show that herderite is anhydrous beryllium-calcium phosphate and fluoride,—with traces only of alumina and ferric oxide and perhaps a little water. The traces of alumina are owing to slight admixtures of traces of mica and albite.

Somewhat doubtful is the exact quantity of fluorine which it contains. Mr. Mackintosh determined its quantity from the excess of lime which he found. A determination which I have made in the same manner gave me a far lower result, instead of 11.32, only 8.93 per cent. My direct fluorine determination is probably too low, owing to the incomplete decomposition of the mineral by fusion with silica and sodium carbonate and the difficulties in the separation of fluorine from such a solution. A doubt also exists as to the 0.61 per cent loss by fusion with plumbic oxide, whether it is water or lead fluoride.

As all my material was used up I could not attempt any other determination for clearing up these doubtful points.

It is to be regretted that the results of Dr. Winkler's two analyses are so very unsatisfactory, and that he has sacrificed the very precious Ehrenfriedersdorf herderite by employing incorrect methods for his analyses.

By ignition he has volatilized the greater portion of the fluorine, then by evaporation with nitric acid the rest may have gone (although nitric acid is less liable to drive off hydrofluoric acid than hydrochloric acid would be); therefore when he subsequently tested for fluorine, there was no more left than sufficient to give a *doubtful reaction.*

Although it is stated (Rose's Qual. Analyse, Leipzig, 1867, p. 212), incorrectly as I believe, that boiling with sodium acetate does not precipitate

glucina, I am not aware that this method has ever been suggested to separate glucina from alumina by boiling a solution, nearly neutralized with sodium carbonate, with sodium acetate. It is a known fact (see Graham-Otto's Anorganische Chemie, by Michaelis, iii, 2 Hälfte, p. 694) that from a solution of beryllium chloride the glucina is precipitated on boiling with sodium acetate.*

. Dr. Winkler does not state that he has tested his so-called *alumina* for its purity, which is unfortunate, or he would have found that a slight trace of it might have been present, but that the precipitate was nearly pure glucina. *There can be very little doubt that the Ehrenfriedersdorf and Stoneham mineral are identical in composition.* There is also a larger percentage of ferric oxide in Dr. Winkler's analysis than found by me. Might this not have come from the molybdic acid which he used? The ammonium molybdate—prepared from Merk's molybdic acid—which I use contains in 100^{cc} 0.002 grms. ferric oxide. As I used measured quantities, a corresponding amount of ferric oxide was deducted.

UNIVERSITY OF PENNSYLVANIA, *Philadelphia, October 17, 1884.*

Notes on the Natural Bridge of Virginia. By Charles A. Ashburner.

(October 3, 1884; see page 690.)

During a recent trip to Virginia (September 2 to 6), I visited the Natural Bridge, and although in possession of the tourist guide book of the locality (edition of 1884) and the admirable articles published by Major Jed. Hotchkiss in "The Virginias," I failed to obtain certain information relating to the bridge which would be of special interest to the topographer and geologist. Some of the observations which I made, although of a general character, may be of interest to members of the American Philosophical Society.

The bridge is undoubtedly the remnant of the top of a cave which was

* In order to show the value of the method used by Dr. Winkler for the separation of alumina and glucina, a quantity of beryllium carbonate was dissolved in hydrochloric acid, evaporated to dryness, diluted with about 150^{cc} of water, nearly neutralized with sodium carbonate, then about 2 grams of sodium acetate were added and the solution heated. At about 80° it became turbid, and after two hours boiling a considerable precipitate had formed, which was filtered off and washed. It was dissolved in dilute hydrochloric acid, then sodium hydrate was added to redissolve the precipitate, then it was diluted with much water and gave on boiling beryllium hydrate, which after ignition weighed 0.0855 grams. The filtrate from the precipitate produced by sodium acetate was precipitated by ammonia and gave 0.2705 grm. This shows that 24.3 per cent were precipitated by boiling, and that the method is worthless for the separation of glucina from alumina. By a greater dilution and a more strict neutralization perhaps all the glucina might have been precipitated.

probably formed long before the Luray Cavern, which is excavated out of the same limestone formation. The bridge seems to be located in the centre of a gentle basin or syncline in the strata, which may account for the roof of the ancient cavern being left at this special point. The height of the bridge has evidently been much augmented by a lowering of the bed of Cedar creek through the agency of chemical and mechanical erosion after the destruction of the original cavern. The height of the cavity at the point where the bridge now exists being in consequence very much less than the present height of intrados of the bridge arch.

The elevation above ocean level of the railroad track at Natural Bridge Station on the Shenandoah Valley R. R., is 760 feet, and the elevation of Cedar creek under the north face of the bridge arch is 915 feet, as determined by two independent lines of barometric levels which I ran from the railroad station to the bridge. The height of the crown of the arch on the north side at the "Lookout Point" is 188 feet above the creek, measured with a cotton twine, which was the only line of the required length which could be obtained. The same measured by barometer (Short and Mason aluminium aneroid), was determined as 186 feet. Neither of these methods of measurements are sufficiently exact to permit of a final statement, but are of interest in the absence of more definite data. The thickness of the arch under the crown on the north side is approximately 46 feet, and on the south side 36 feet.

Much has been written and published about this Natural Bridge since the appearance, a century ago, of the Travels of the Marquis de Chastellux in North America, in 1780–2, but there appears to be a lack of a complete description of the bridge and its surroundings which is readily available, which would prove of special value to the topographer and geologist.

Stated Meeting, November 7, 1884.

Present, 18 members.

President, Mr. Fraley, in the Chair.

Col. Ludlow, Dr. Randolph, and Mr. Dickson, new members, were introduced to the presiding officer and took their seats.

Letters of acknowledgment were received from the Royal Academy at Madrid (XVI, i, 113, 114); the Society of Antiquaries of London (415); and the Maine Historical Society (115).

A letter of envoy was received from the Meteorological Office, Royal Society, London.

Donations to the Library were reported from the Royal Academy of Belgium; the Annales des Mines; the Revue Politique; the Meteorological Council of the Royal Society, and London Nature; the Cambridge Philological Society; the Natural History Society at Montreal; the Boston Society of Natural History; the American Philological Association at Cambridge; the American Journal of Science; the American Chemical Journal; the Franklin Institute; Pennsylvania Historical Society; Prof. J. P. Lesley; Mr. Henry Phillips, Jr.; Mr. A. E. Foote; the Wyoming Historical and Geographical Society; the Commissioners of Education; the Secretary of the Navy; the United States Fish Commission; the United States National Museum; the United States Naval Observatory; the Smithsonian Institution; the American Journal of Mathematics; Major Jed. Hotchkiss, of Staunton, Va.; the editor of the Western Magazine, Cleveland; the Colorado Scientific Society; the Astronomical Observatory of Mexico, and the Imperial Observatory of Rio de Janeiro.

Dr. Rushenberger accepted his appointment to prepare an obituary notice of Dr. R. E. Rogers.

Mr. Vaux accepted his appointment to prepare a notice of Mr. Henry M. Phillips.

The death of Mr. John Biddle, of Philadelphia, October 19, aged 70 years, was announced.

The death of Mr. C. E. Rawlins, of Liverpool, aged 71 years, was announced.

Dr. Syle exhibited copies of the Shanghai Chinese Illustrated News, picturing the defeat of the French troops by the Chinese in the late battles; and described the peculiarities of the structure of the Chinese language.

Prof. Cope presented "An Analysis of the bark of the *Fouquieira splendens*," by Miss Helen C. D. Abbott.

Prof. E. D. Cope mentioned some of the results of his studies on the Batrachian and Reptilian fauna of Mexico and Central America, which had been prosecuted by the use of material mainly placed at his disposal by the Smithsonian Institution.

The total number of species described up to date is six hundred and ten, which is described as follows:

		Genera.	Species.	
Batrachia.	Urodela	6	15	120
	Gymnophiona	4	7	
	Anura	31	98	
Reptilia.	Crocodilia	2	3	488
	Testudinata	11	28	
	Lacertilia	42	183	
	Ophidia	92	274	

On motion of Dr. Brinton it was

Resolved. **The expediency of preparing and printing a Dictionary of the Lenni Lenâpé language, based on that of the Rev. David Zeisberger, and thus completing the presentation of that language, begun in our Transactions in 1827 by our former President, Peter Stephen Duponceau, be referred to the Publication Committee, with instructions to report at the first regular meeting in January, 1885.**

Pending nominations Nos. 1031, 1032 and new nomination No. 1033, were read, and the meeting was adjourned.

Stated Meeting, November 21, 1884.

Present, 15 members.

President, Mr. Fraley, in the Chair.

An acknowledgment of the receipt of Proceedings Nos. 112, 114, 115 was received from the Royal Zoölogical Society of Amsterdam.

A letter of envoy was received from the Librarian of the University of California.

A letter was received from the United States Department of the Interior, offering copies of the Blue Book, or Official Register of the United States.

A circular invitation was received from the Natural History Society at Bamberg, to assist at the celebration of its Fiftieth Anniversary, on November 8, 1884.

Donations for the Library were received from Mr. Paul Albrecht, of Brussels; the Geographical Society at Paris; Royal Academy of History at Madrid; Royal Meteorological and Astronomical Societies of London; London Nature; the Boston Society of Natural History; Science Record; New York Meteorological Observatory; American Journal of Pharmacy; Mr. Henry Phillips, Jr.; the Maryland Historical Society; Johns Hopkins University; United States Fish Commission; United States Department of the Interior; Kansas State Historical Society, and University of California.

The death of Eli K. Price, sènior Vice President of the Society, at his residence, in South 15th street, Philadelphia, on the 11th inst., in the 88th year of his age (born July 20, 1797), was announced.

The following contributions to the Society were read:

1. Notes on the Geological Structure of Tazewell, Russell, Wise, Smyth, and Washington counties, of Virginia, by John J. Stevenson, Professor of Geology in the University of New York, with seven cross sections and a geological map.

Mr. Lesley remarked that—

This memoir was a continuation of Prof. Stevenson's description of the Geology of Southwestern Virginia, read before the Society, August 20, 1880, January 21, 1881, and October 7, 1881; but without further reference to the economics of the region.

The absence of the Chemung and Portage and Genesee formations VIII *f, e, d,* from long outcrops in Lee, Wise and part of Scott counties (although the Chemung is present on Indian creek, &c. further east); the absence of the coarser members of the Hamilton VIII *c*, and the Marcellus VIII *b*, so that only 900 feet of black slate is left; the absence of the Upper Helderberg VIII *a*, Oriskany VII, Lower Helderberg VI, and Onondaga V *b*—leaving merely the Clinton V *a*, and Medina IV *b, c,* which, however, thin out and disappear themselves, *but in a southeasterly direction*—are facts of importance to the proper understanding of the original source, or rather sources of our Palæozoic deposits.

The logical discussion of facts relating to the anomalous salt and gypsum deposits along the Holston, at Saltville and elsewhere, is specially valuable. The independence of the gypsum clays as regards the Palæozoic floor-rocks on which they rest, and the evident erosion of the gypsum before the deposit of the blue clay, upon which again the *Mastodon* conglomerate lies, are important steps of an argument resulting in a theory

that the gypsum is not older than Tertiary times, and that it owes its origin (as in the Great Salt Lake of Utah) to the meeting of two systems of drainage waters, one from a region furnishing an abundance of lime water, and the other from a region furnishing an abundance of copperas water.

This memoir is not only valuable for its new facts, but for its correction of mistakes made by me in my survey of the region in 1870. A re-survey of any geological field by another, or by the same competent geologist, is sure to produce such results; and the "constants of science" can only be obtained by this process of reiteration. My mistake of identifying the fault at Saltville with the Walker mountain fault is a case in point. Prof. Stevenson shows their distinction.

The total absence of the Catskill formation No. IX, and the nearly total absence of the Pocono formation No. X, two formations measuring together in Middle and Eastern Pennsylvania at least 8000 feet, is worthy of especial notice, as it goes far to confirm the apparent lack of IX and thinness of X at no great distance behind the Allegheny mountain in western Pennsylvania. As we know nothing of the south-eastern limit of these formations, and merely see them at their last outcrop growing thicker in that direction, and also north-eastward, the idea of a closed basin, however large—perhaps extending to Scotland—may challenge respectful consideration.

On motion, the Secretaries were authorized to publish a colored map of the district like that in Vol. XIX, page 219.

2. The Limits of Stability of Nebulous Planets, by Prof. Daniel Kirkwood.

3. On the Genealogy of the Vertebrata, and the Theory of Degradation as demonstrated by it, by Prof. E. D. Cope.

The minutes of the last meeting of the Board of Officers and Members in Council were read, and on motion the recommendations therein contained were approved and adopted.

1. *Resolved*, That the Proceedings be hereafter published quarterly, or oftener, at the discretion of the secretaries.

2. *Resolved*, That all members not paying an annual contribution be charged one dollar annually for the printed Proceedings.

It was explained that the Post-Office laws of the United States require not only a quarterly issue, but a bona fide subscription list, for placing any printed matter under the head of third-class matter.

The Secretaries will not only make this notification and explanation, but will send a circular letter to such members of the Society soliciting their assent.

3. *Resolved*, That the Indian Picture Rock be obtained at a total cost not exceeding $50 for purchase, preparation and transportation.

4. That an appropriation of two hundred and seventy-five dollars ($275) be made for heliotype views of the Society's Hall, within and without, to illustrate the forthcoming Volume I, Part i, Proceedings of the Society from 1744 to 1837.

5. That a circular letter be sent to members, urging them to take measures for the preservation of the monuments of antiquity in their several localities.

6. That it is not expedient for the Society to take any part in the proposed American Exhibition in London in 1886.

The alterations made in the garrets of the Hall for purposes of storing and arranging the Society's stock of publications, were reported and approved, and the meeting was adjourned.

Stated Meeting, December 5, 1884.

Present, 13 members.

President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Judge Jas. R. Ludlow, Prof. G. vom Rath, Dr. A. S. Gatschet, and Rev. Dr. H. C. Trumbull.

Letters of acknowledgment were received from the Societas Floræ et Faunæ Fennica, at Helsingfors (107, 108, 113), asking for back numbers; from the London Royal Society (XVI, i; 112, 113, 114); from the Verein für Vaterländische Naturkunde at Stuttgart (XVI, i; 112–114); and from De Lau & Co., London (see MS. Minutes).

A letter proposing exchange of duplicates was received from the Mercantile Library.

Letters of envoy were received from the Meteorological Office of the Royal Society, London, and the Society at Helsingfors.

Donations to the Library were received from the Royal Academies at Berlin, Turin, Modena, London and Edinburgh; the Observatories at Adelaide, Oxford and Brussels; the Geologi-

cal Survey of India; the Society at Helsingfors; the Archives of Physical and Natural Sciences at Geneva; the Anthropological Society and Royal Geological Institute at Vienna; the Natural History Societies at Altenburg, Bremen, Bonn and Stuttgart; the German Geological Society; the Society of Natural and Medical Sciences at Giessen; the Horticultural Society at Görlitz; the Physical-Economical Society at Königsberg; the Geographical and Natural History Societies at Leipsic; the Astronomical, Geological and Geographical Societies at London; the Boston Society of Natural History; the Essex Institute; Museum of Comparative Zoölogy; American Journal of Science; New Jersey Historical Society; Franklin Institute, Henry Phillips, Jr., Prof. E. D. Cope; Kosmos; the Second Geological Survey of Pennsylvania; Prof. Ira Remsen, of Baltimore, and Major Hotchkiss, of Stanton, Virginia.

Mr. Henry Phillips, Jr., presented two valuable catalogues of collections of coins; one of Jerome de Vries, Jr. of Amsterdam; the other of the Marquis Remedi of Sarzani, hand somely illustrated with heliotype plates.

Prof. John J. Stevenson of the University of the City of New York communicated a paper entitled: "Some notes respecting metamorphism."

Mr. Carson read by appointment an obituary notice of the late Gen. A. A. Humphreys.

Dr. Frazer exhibited and explained his invention of a form of hand-compass, in which the needle is preserved from injury by carriage.

Mr. Ashburner exhibited and described a new map of the anthracite coal region with columnar lists of the production of each mine.

The Treasurer read his annual report, which was submitted to the Committee on Finance.

Pending nominations Nos. 1031 to 1033 were read, and the meeting was adjourned.

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Papers and Communications.

Members Elected.

short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of——— A.D.———." And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from the other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for the addition, to the said premium, of such amount as the Society may from time to time think suitable, or for the institution of other premiums.

The treasurer shall, at the first stated meeting of the Society in the month of December annually, make a report of the state of said fund and of the investment thereof.